A paper
prepared for the

Economic Council
of Canada

P.O. Box 527
Ottawa, Ontario
K1P 5V6

Un document
préparé pour le

Conseil économique
du Canada

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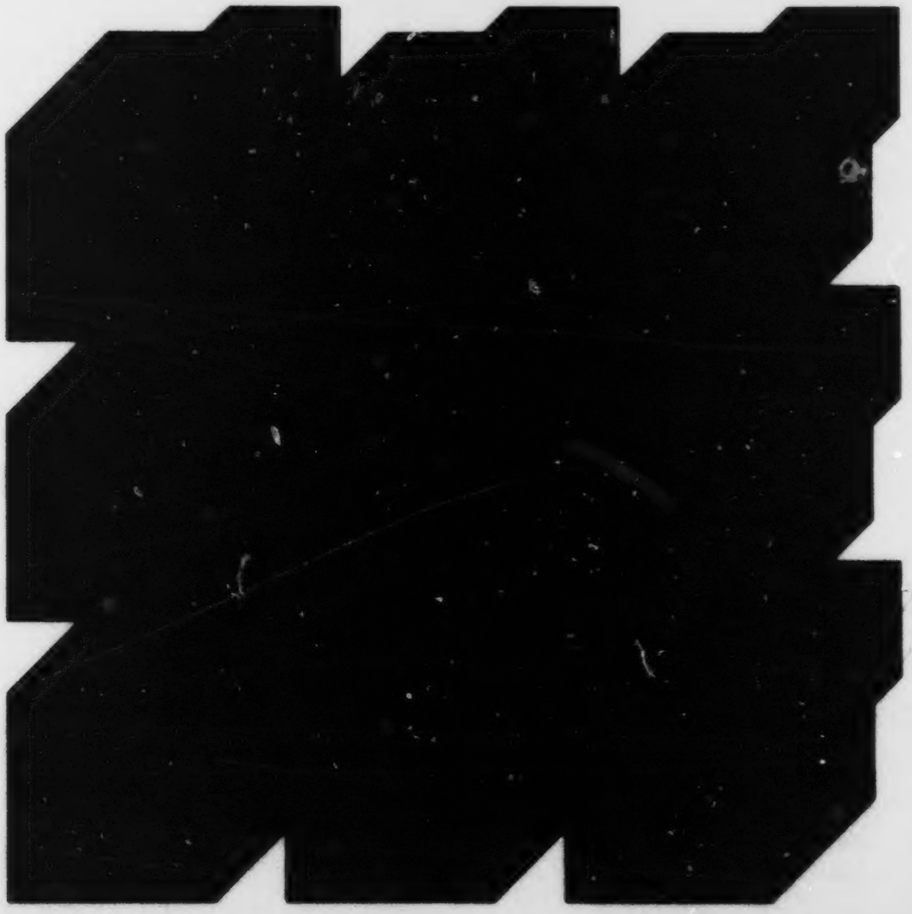

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DISCUSSION PAPER NO. 275

Employment Instability in Western Canada: A Diversification Analysis of the Manufacturing and Other Sectors

by Harry H. Postner and
Lesle M. Wesa

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ISSN-0225-8013 February 1985

PREFACE

This discussion paper is one of a number of background studies prepared for the Economic Council's consensus document Western Transition. In particular, the paper serves as background for the Manufacturing Chapter 13 and Appendix E of the consensus document. It should be noted that the document refers to the present study under its original title, namely "Industrial Diversification In Western Canada: A Portfolio Analysis of the Manufacturing Sectors". The title has since been revised to the one used in the present study, namely "Employment Instability in Western Canada: A Diversification Analysis of the Manufacturing and Other Sectors".

Many individuals contributed directly or indirectly to this paper. We would like to thank Neil Swan and the Chairman of the Economic Council, David Slater, for important comments on an earlier version of this work. Tom Schweitzer and Mike Percy also contributed significant remarks or suggestions. Bob Goguen performed a valuable service in obtaining the Stanford University computer package for quadratic programming which plays a vital role in this study. The programming calculations of Chapter 5 and 6 were carried out with remarkable efficiency by André Bourdon.

Roland Ouellette and Pierre Prud'homme of the Labour Division at Statistics Canada were helpful in providing data from the

Employment, Payrolls and Manhours survey. Much of the data was stored on microfilm and Dorothy Barrette, Gilles Longtin and Diane Mantil assisted in its transfer to worksheets. Gilles Longtin also produced the computer graphic charts that appear in Chapter 4. John Serjak was instrumental in obtaining the assistance for this study when needed.

The text of Chapters 1, 3, 4, 5 and 6 and Appendix A were written by the senior author, Harry Postner. Lesle Wesa wrote Chapter 2 and Appendix B and was also responsible for putting together the tabular results in Chapters 2, 3 and 4. Finally the two authors are alone responsible for any errors of omission or comission.

RÉSUMÉ

L'auteur commence d'abord par mesurer l'instabilité de l'emploi dans les quatre provinces de l'Ouest canadien. Il l'analyse, pour chaque province, du point de vue de la diversification industrielle, et en accordant une attention particulière aux industries manufacturières. Il examine ensuite l'instabilité de l'emploi et la diversification économique qui s'y rattache - pour la période de 1970 à 1983 et à partir d'observations mensuelles de l'emploi - de façon à tenir compte des variations tant à court qu'à long terme. L'analyse détaillée couvre tous les principaux secteurs des économies provinciales, celui de la fabrication étant en outre subdivisé, comme d'ordinaire, en quatorze industries distinctes.

Dans cette étude, l'auteur examine ensuite la possibilité de modifier (de façon marginale) les schèmes provinciaux de diversification de l'emploi, en vue de réduire l'instabilité dans ce domaine. La méthode fondamentale pour y arriver est empruntée aux instruments d'analyse qu'offrent la théorie et les pratiques de la gestion de portefeuille. Cette approche, toutefois, est considérablement modifiée afin de l'appliquer au sujet étudié, c'est-à-dire l'instabilité de l'emploi. L'analyse empirique met en évidence les secteurs et industries manufacturières de chacune des provinces de l'Ouest, où le comportement caractéristique de l'emploi peut

permettre d'en réduire les variations. Or, ce sont précisément là les secteurs et les industries où l'emploi devrait être favorisé. L'étude montre qu'il est possible de réduire sensiblement l'instabilité de l'emploi dans ces provinces, particulièrement au Manitoba et en Saskatchewan, en favorisant l'expansion de certaines de leurs industries manufacturières. De plus, en partant d'une analyse "limitée" de portefeuille, il est encore possible de réduire de beaucoup l'instabilité de l'emploi sans sacrifier les autres objectifs économiques des provinces, comme la croissance de l'emploi et les niveaux de revenu.

La description et l'analyse que présente l'étude sont suffisamment générales pour s'appliquer à n'importe quelle province - ou même à une de ses régions - qui voudrait réduire son degré d'instabilité de l'emploi. L'étude est en somme un "manuel pratique" qui indique la série minimale de données statistiques nécessaires pour structurer l'analyse et appliquer les programmes informatiques connexes. Ajoutons, pour conclure, qu'elle offre un certain nombre d'orientations pour d'autres travaux, dont une analyse des coûts et avantages de mesures propres à favoriser la stabilité de l'emploi dans les provinces, à partir du cadre systématique que fournit la méthode de gestion de portefeuille.

ABSTRACT

The study first focuses on measuring employment instability in the four provinces of Western Canada. Instability is analyzed from the viewpoint of industrial diversification in each province. The manufacturing sectors of Western Canada are given special attention in this analysis. Employment instability and related economic diversification are studied over the time period 1970-1983 on the basis of monthly employment observations so that both short-term and medium-term instabilities are taken into account. The disaggregated analysis covers all major sectors of the provincial economies with the manufacturing sector further disaggregated into (usually) 14 distinct industries.

The study then considers the possibility of (marginally) changing provincial employment patterns of diversification so as to reduce aggregate levels of employment instability. The basic approach to this problem is borrowed from the analytical tools of portfolio investment theory and practice. The portfolio approach, however, is considerably modified for application to the employment instability context of this study. The empirical analysis reveals the individual sectors and manufacturing industries in each Western province whose characteristic employment behaviour is in a favourable position to reduce provincial employment instability -- these are the sectors and industries whose employment should be promoted. The study shows that it is possible to significantly reduce provincial employment instability, especially

in Manitoba and Saskatchewan, by favouring the expansion of certain industries within the provincial manufacturing sectors. Moreover, on the basis of a "constrained" portfolio analysis, employment instability can still be significantly reduced without sacrificing other economic goals such as provincial employment growth and income levels.

The description and analysis of the study is sufficiently general for application to any provincial economy, or even sub-provincial area, interested in reducing their measure of employment instability. The study provides a "working manual" showing the minimum set of statistical data required to structure the analysis and perform the related computer programs. In conclusion there are a number of directions for further work including a cost-benefit analysis of promoting provincial employment stability using the systematic framework provided by our modified portfolio approach.

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Chapter 1: INTRODUCTION

This study is mainly concerned with industrial diversification in the four provinces of Western Canada. We present an empirical and intensive development of one aspect of economic diversification. Our basic approach is borrowed from portfolio analysis of financial investment theory, but only after considerable modification required for the industrial employment application of the study. The manufacturing sectors of Western Canada are given special attention. The study is written in such a way that the tools of analysis can be applied to any province or even sub-provincial areas. The text is essentially non-technical; we spell out, in words and many examples, arguments usually expressed mathematically. The general idea is to make the approach of this study available to a wide collection of readers.

Scope of Study

The notion of "diversification" is now a common one in economics. Diversification is a key conceptual ingredient in many fields of analysis such as the modern theory of the firm, international trade, household economic behaviour, as well as applications of financial investment theory. The diversification concept also turns up in discussions relating to industrial policy at both the national and provincial levels. Indeed, there are many references available to such discussions concerning the four provinces of Western Canada.[1]

On reading this literature, particularly with reference to provincial industrial policy, it soon becomes apparent that the concept of "diversification" has various meanings. We may distinguish two principal meanings.[2] First, industrial diversification may be promoted as a policy to strengthen the security of long-term future growth of a provincial economy. For example, some (non-renewable) natural resource sectors of the Western provinces may be expected to experience relative declines in the future. The Western provinces are presently dependent on their natural resources and related industries to a significant extent. Then, in order to maintain high rates of economic growth, it may be argued that the Western provinces should become more "diversified" -- turning a larger share of their employment and income to other industries with more secure long-term growth prospects and which are essentially unrelated to the natural resource sectors. This is one principal meaning of "diversification". The second meaning is primarily concerned with the stability of the economic growth process. Again, with reference to the Western Canada provinces, it may possibly be argued that their relative dependence on natural resources has created a sensitivity to "boom and bust" cycles. Even though long-term growth prospects may be favourable, the corresponding economic growth process would be unstable. Such instability has an uninsured economic cost dimension not necessarily covered by the benefits of long-term growth and specialization. Therefore, the Western provinces may again be recommended to become more "diversified" -- turning a larger share of their employment and income to other industries that experience an inherently more stable economic growth process in both the short term and medium term.

It seems reasonable to ask: which meaning of the diversification concept is "correct" for industrial policy? The answer, of course, is: both! In this study, however, we are almost exclusively concerned with the second meaning. We do, nevertheless, provide links with the first meaning of diversification and, indeed, it will be seen that the two principal meanings are complementary in important respects. The distinction between the two meanings, though, is sufficiently clear to bear in mind throughout the study.

Industrial diversification to promote stability of economic growth is, then, the main concern of the study. We show that a rigorous empirical analysis of industrial diversification in Western Canada is possible by adapting a portfolio approach to the subject. In our portfolio approach, the allocation of employment to each industry of a provincial economy is regarded as an "investment" in human resources. The own-employment instability experience of each industry is characterized by its short-term and medium-term employment fluctuations around the long-term trend. But we also account for the cross-employment fluctuation experiences of all pairs of different industries in the same province. Industries whose employment fluctuations around trend are typically countervailing with respect to employment fluctuations of most other industries in the same province are then in a favourable position to lower provincial employment instability. Employment in such industries represents "effective" economic diversification. We program optimal reallocations of industrial patterns of employment in order to reduce provincial levels of instability. The reallocation of industrial employment is performed in such a way so as not to decrease provincial returns (earnings) to employment. There are other economic constraints on the program as well.

All this is very much in the spirit of portfolio analysis used in applications of financial investment theory.[3] We show that reducing provincial employment instability, subject to reasonable constraints, is equivalent to promoting provincial industrial diversification (second meaning), subject to the same set of constraints. The analysis can be applied to any provincial economy, or even sub-provincial area, interested in reducing employment instability, provided that a minimum set of statistical data are available to structure the analysis and program. A provincial economy need not experience "boom and bust" cycles in order to benefit from the techniques of optimal portfolio analysis applied to industrial policy.

The study gives special attention to the manufacturing sectors of the four Western provinces. The main reason for this stems from the fact that the "promotion" of secondary manufacturing is often offerred as a possible "solution" to the diversification problems (both meanings) of the Western provinces.[4] We, therefore, provide more disaggregated detail for the manufacturing sector in our data base than for other industrial sectors. The analysis, though, is meant to cover all sectors of the provincial economies. Indeed, the importance of cross-sector employment experiences (mentioned in the preceding paragraph) shows that in a portfolio analysis of industrial diversification, it is essential for the manufacturing sector to be analyzed in the context of the provincial economy as a whole. The disaggregation of manufacturing also reveals the potential for reducing provincial instability by changing the industrial employment mix within the respective manufacturing sectors. At the same time we provide abundant evidence towards testing the hypothesis that the promotion of secondary manufactuirng is a possible "solution" to the diversification problem (second meaning) of Western Canada.

Before outlining the contents of the study, there is one further point that should be clarified. We show that industrial diversification, to promote greater provincial economic stability, cannot be expected to occur naturally through market forces. Individual industries, whose characteristic employment behaviour is in a favourable position to reduce provincial employment instability, have no market incentive for (relative) expansion -- their potential stability-promoting activities are purely external. Therefore it would seem that a systematic analytical framework, provided by this study, that yields concrete estimates of stability-promoting "winners" and instability-promoting "losers" is not an academic exercise. The framework is directly useful for government policy intervention (further discussed in Chapter 6).

Outline of Contents

The text of the study is basically non-technical. We present a description and analysis that can be understood by readers with some general background in economics and statistics. No special knowledge of portfolio investment theory is required to read the text. In fact the study is virtually free of risk-aversion conceptualizations that often dominate the portfolio and related literature.

Chapter 2 provides the statistical background to our data base. It will be seen that our empirical analysis covers the time period 1970-83 and is actually based on monthly data observations. Such observations are required in order to account for short-term as well as medium-term employment instabilities. Chapter 3 contains a description of the four basic statistical measures that enter our analysis. The measures relate to: (1) average employment levels (or employment distribution), (2) average employment earnings, (3) long-term employment growth rates, and (4) provincial- and industry-level employment instabilities. The provincial economies include eight distinct industrial sectors one of which is manufacturing; the latter sector is disaggregated into fourteen distinct industries. A highlight of this chapter is that all measures, including the important measures of employment instability, are shown for Quêbec and Ontario as well as the four Western Canada provinces; Manitoba, Saskatchewan, Alberta and British Columbia. This permits key comparisons of economic measures between Western Canada and Central Canada.

So far the study is primarily descriptive. In Chapter 4 we provide an introduction to industrial diversification analysis. Some basic concepts and distinctions are developed. The analysis is oriented to clarifying some apparent ambiguities that arise when the measure of employment instability is registered at aggregate and disaggregated levels. We explain why employment instability for an aggregate entity can be less than the corresponding measures for all disaggregated entities. This is a desirable property towards which "effective" industrial diversification should work.

Chapter 5 is the longest chapter of the study. Here everything comes together. We construct an optimal diversification framework, borrowed and modified from portfolio analysis. A computer (quadratic programming) algorithm is applied to minimize provincial levels of employment instability, subject to constraints and to certain boundary limitations on changes in employment distribution. The constraints guarantee that observed levels of provincial long-term employment growth and provincial average employment earnings will not be sacrificed to reduce provincial employment instability. All the Western provinces can attain significant reductions in their levels of employment instability on the basis of various scenarios (rules of the game) under which the computer programs are run. Some scenarios, though, are more effective than others, depending on the particular province involved. Our scenarios cover both static and dynamic (very long-term multi-iteration) cases. We find that the two major constraints, mentioned above, are not always binding. Sometimes reducing provincial employment instability yields, as a by-product, higher levels of long-term employment growth -- "free of charge" so to speak.

Chapter 6 has two major purposes. First the industrial policy implications of the study are spelled out. Even within our historical data limitations, we feel that the study offers some important policy lessons that have been overlooked in previous discussion. The framework here becomes more flexible and the perspective becomes more forward looking. There is no need to adopt a purely mechanical application of optimal diversification analysis (or any other economic analysis for that matter). The portfolio technique is still essential -- there is no other way to systematically put everything together. Indeed, many of our results are entirely counterintuitive or, at best, can only be explained "after the fact". The second major purpose of Chapter 6 concerns suggestions for further research. Here we spell out the data limitations of our particular framework and show what could be done, or should be done, with a more liberal data base. The suggestions consider finer disaggregation, incorporation of entirely new industries, and extended constraints relating to provincial output and income measures. Most important, individual provinces or other regional areas desiring higher levels of economic stability, need not be restricted to statistical data sources that are "comparable" to other provinces or regions. We, working at the federal level, are somewhat commited to these considerations. But individual provinces are perfectly free to assemble whatever data can be made available that satisfies the minimum requirements of an optimal diversification analysis.

The study concludes with two technical appendices. Appendix A provides mathematical formulae and proofs of assertions made throughout the text. Where the mathematics is already available in well-known sources, we give references or brief outlines of the required formalisms. There are two key aspects in this appendix: (1) the properties of positive semi-definite matrices, and (2) the role of the Lagrangian multiplier in quadratic programming analysis. Appendix B is a complement to Chapter 2. Statistical data sources, coverage tests of the data base and computer graphic manipulations are discussed in more technical detail.

Finally, it might be noted that the study could be read at various levels. Chapter 2 can be omitted without loss of continuity (the most important material is summarized in Chapter 3). Readers already acquainted with the portfolio approach to diversification analysis can begin with Chapter 5 (the first section of the chapter has a recapitulation of earlier material). It is even possible for readers primarily interested in policy implications to go directly to Chapter 6. Appendix A is only useful for mathematically-inclined readers who wish to have a complete technical understanding of the study. The study as a whole, including the technical appendices, is compiled in the flavour of a working manual. There are almost one hundred tables giving a full set of statistical measures and many instructive examples of application.

Notes

1 See, for example, Richards and Pratt (1979), Drugge and Veeman (1980) and Jenkin (1983).

2 Thanks are due to Neil Swan for suggesting the following distinction. This theme and others are developed in Economic Council Canada (1984), especially Chapter 13 for which the present study provides documentation.

3 The best single reference is Tobin (1965). An application of portfolio analysis to industrial diversification was made by Conroy (1974). Our analysis differs in important technical respects from Conroy; see Appendix A for complete details.

4 See again the references in footnote 1 of this chapter.

[illegible]

[illegible]

[illegible]

Chapter 2: BACKGROUND TO THE DATA

The approach we chose to examine industrial diversification in Western Canada necessitated a database satisfying several requirements. Since we were studying employment instability in the Western provinces with particular interest in manufacturing, we needed data available by month over a period sufficiently long to capture medium and long-term variations, data disaggregated by province and by sector with considerable industrial detail within manufacturing, and data for which there existed compatible wage and salary data. Employment data compiled from Statistics Canada's monthly Employment, Payrolls and Manhours survey completely met our needs. Only accessibility of the data presented a problem. Chapter 2 describes in some detail the characteristics of our database. It begins with a discussion of an alternate data source which was readily available but only moderately suitable and which was used in early experiments with the methodology and in the calculation of preliminary results. This is followed by an in depth look at the features and applicability of the database which we ultimately chose. Finally, we describe the source and characteristics of the associated employment earnings data and we elaborate on an extension of the employment data to cover an important but missing sector.

Initial Experimentation with Labour Force Survey Data

The nature of our investigation was such that certain basic technical requirements had to be satisfied by the employment data. It had to be available by month and by province over a minimum period of ten years. One possibility was the Census of Manufactures which yields employment data by industry and at a finely disaggregated level for the manufacturing sector. But it fails to satisfy even the very rudimentary list of requirements. It is available by province and from the 1950s but it is only compiled annually -- making analysis of the instability problem impossible. The Labour Force Survey (L.F.S.) also produces employment data by sector and, in this case, the basic set of conditions is met. The L.F.S. data fails to possess most of the other attributes outlined in the introduction to this chapter making it quite unsatisfactory from other points of view but, because it did meet the basic conditions and because it was so easily available, we decided to use it in a few trial runs of the methodology.

The Labour Force Survey is a sample survey of households. Interviews are conducted in representative households across the country. An individual is counted as being employed if he or she is 15 years of age and over and did any work at all during the reference week or had a job but was absent due to illness, labour dispute or vacation. Work is defined to include work for pay or profit, that is, paid work in the context of an employer-employee relationship or self-employment, and also includes unpaid family work. Industry coverage is all-encompassing and entails all sectors of the economy. Each employed person is classified as belonging to one of nine main sectors -- agriculture, other primary industries, manufacturing, construction, transportation, communication and other utilities, trade, finance, insurance and real estate, or public administration.

By contrast to the excellent sectoral coverage of the LFS, the industrial detail within sectors is very poor. Employment in manufacturing, the focus of our study, is disaggregated into 20 industries at the 2-digit level but only by region and only where values exceed 4,000. Any data less than 4,000 are suppressed because of the question of the reliability of the estimates. Statistics Canada will meet special requests for manufacturing data disaggregated by province but the withholding of values less than 4,000 means that many entries are missing. This is particularly a problem in the manufacturing industries of the four Western provinces where the employment numbers are so small.

Furthermore even those values that do appear are rounded to the nearest thousand. This is a critical handicap in a study of instability where period to period changes are so important. An employment level of 4,499 for example, would be rounded to 4,000 and an employment level of 4,501 would be rounded to 5,000. If these levels were recorded in consecutive months, the actual percentage change would be 0.04 per cent while the percentage change from rounded levels would be 25 per cent. Actual and rounded values would place quite a different light on developments between the two months.

In 1975, Statistics Canada introduced substantial revisions to the Labour Force Survey. The primary purpose was to provide a more comprehensive range of information on employment and unemployment and the changes were of two types. There were a number of enhancements of an operational or statistical nature (including a major revision of the sample, the introduction of refinements in sampling techniques, and improvements in data collection, quality control, and data processing) and there were a number of changes in the survey questions (including the collection of new data and an increase in the specificity of the questions). It is the latter set of changes which had the greatest impact on the data. Both the old and the new surveys were run in 1975 so there was one year of overlapping data. Statistics Canada used this information to link the historical data with the more recent data for selected employment series. They did not perform the link for sectoral employment by province, however. Consequently that employment data which we can derive from the LFS has a break in 1975.

Despite its obvious shortcomings, it was very accessible and it did have universal coverage. This prompted us to experiment with the LFS data. To overcome the lack of industrial detail, we requested a special aggregation of the manufacturing industries.

Industries whose output was mainly directed to local markets were combined into group one and they included food and beverages and printing, publishing and allied manufacturing industries. Group two included primary manufacturing industries (tobacco products, wood, paper and allied, primary metal, non metallic mineral products and petroleum and coal products) and group three covered secondary manufacturing industries (rubber and plastic products, leather, textiles, knitting mills, clothing, furniture and fixtures, metal fabricating, machinery, transportation equipment, electrical products, chemical and chemical products, and miscellaneous manufacturing). To reduce the number of restricted values we asked that the cutoff point be 2,000 rather than 4,000 employees and to reduce the sensitivity of the results to strictly random fluctuations caused by the use of monthly data we used observations based on two-month averages. We handled the discontinuity in the time series by considering two separate time periods -- 1966-74 and 1975-83.

The data thus altered were used to calculate "measures of employment instability" for each provincial economy as a whole and sectoral "employment instability measures" for each of the eleven sectors in each province (three of which were local, primary and secondary manufacturing). Chapter 3 describes in detail the meaning and derivation of these "employment instability measures" and the results flowing from the use of the LFS data at the aggregate level of the provincial economies. Suffice it to say here that the exercise with the household Labour Force Survey data gave us opportunity to experiment with our methodology (see Appendix B) and yielded instability measures at the aggregate level having the advantage of universal coverage and which could be compared with stability measures derived from the database we eventually selected (see again Chapter 3). The instability measures at the disaggregated level were disappointing, as might be anticipated. Rounding the data to the nearest 1,000 heavily biased the results such that the smallest industries invariably were the most unstable. Splitting the 1966-83 period into two sub periods meant neither time series was long enough to reflect long-term structural developments. When compounded with the lack of manufacturing detail and the absence of strictly comparable wage data, it became obvious that the Labour Force Survey data was not suitable to the needs of the study. We take further consolation in our rejection of the database by noting that the LFS is a survey of households -- not establishments. Its main thrust is toward the mix of employment and unemployment in the labour force and its presentation of the industrial mix of employment is more an offshoot of the survey than an ultimate goal.

Selection of Larger-Firm Employment Survey Data

The database most appropriate to analyze the employment instability problem is the one derived from Statistics Canada's monthly survey of industry -- the Employment, Payrolls and Manhours survey. The survey's stated purpose is "to measure the month-to-month trends of employment, paid hours and earnings"[1] thus rendering employment and particularly employment by sector more than a secondary concern (which was not the case with the LFS) and increasing the possibility of having wage and salary data on a comparable basis. It is a census of larger firms where a firm is defined as any business entity whether incorporated or not and usually, although not always, consists of one establishment. It is considered "larger" when it employs 20 or more persons. This might, at first glance, suggest that the survey is rather limited in its coverage but we shall see that this is not the case. The fact that it is a census increases the reliability of the data since inaccuracy in the results is due only to non-sampling error. The possibility of sampling error is eliminated. An individual is counted as being employed when he draws pay for services rendered or for paid absence and for whom an employer makes CPP or QPP and/or UIC contributions. It includes full-time, part-time and casual employees but excludes owners or partners of unincorporated businesses and professional practices, the self-employed, and unpaid family workers.

All commercial industries are covered by the survey, with the exception of agriculture, fishing and trapping. This means, at the 1-digit S.I.C. level, larger firms from eight major sectors receive questionnaires -- forestry, mining, manufacturing, construction, transportation, communication and other utilities, trade, finance, insurance and real estate, and commercial services. Commercial services include recreational, business, personal and miscellaneous services. To say these eight commercial sectors are "covered" is not to say every type of operation within those sectors is represented in the survey. Within recreational services, for example, there would exist theatres, golf clubs, and amusement parks with more than 20 employees and there would, therefore, be theatres, golf clubs and amusement parks which would be obliged to respond to the survey. It might be difficult, however, to find boat rental agencies or swimming pool facilities with more than 20 employees and thus these operations would not necessarily be captured by the survey. Similarly, within personal services, it would not be hard to find hotels or restaurants or vacation resorts with a staff of more than 20 persons and which would consequently be part of the survey but it would be difficult to find shoe repair shops or barber shops or carpet cleaners of comparable size. The latter would consist generally of "smaller" firms and would be omitted from the census.[2] The non-commercial industries which are intentionally excluded from the survey are public administration and defence and the non-commercial services of education and related services, health and welfare services, religious organizations and private households. Of the industries excluded from the survey, agriculture gave us the greatest concern. The omission of a sector so important to the Western provinces could not be brushed over lightly. More will be said of this later in the chapter and in Chapter 3.

It is clear that the restriction to larger firms prevents 100 per cent coverage of the commercial sectors (excluding agriculture, fishing and trapping). Only a select group of many operations are surveyed and some operations are not surveyed at all. The proportion of total employment covered by the survey varies among industries and provinces. In general however the coverage of the commercial industries is very good and for particular sectors, especially manufacturing, it is excellent. Table 2-1 shows annual employment in 1972 and 1978 as reported by the Employment, Payrolls and Manhours survey as a percentage of estimated total employment. The latter data were estimated by adding together data from the larger firm survey and data from a sample survey of smaller firms plus supplementary surveys. In Quebec, Ontario, Manitoba, and British Columbia coverage in manufacturing was in the neighbourhood of 90 per cent, in Alberta it averaged 82 per cent over the two years, and in Saskatchewan it averaged 78 per cent. Other industries exhibiting good coverage include mining, transportation, communication and other utilities, and finance, insurance and real estate. Commercial services had the weakest representation in the survey. With regard to coverage of individual manufacturing industries, it is impossible to say in the historical period since Statistics Canada has not compiled data on total employment at that level of detail. In March 1983, there was a change in their methodology, however, and an attempt has been made to estimate coverage in these industries for that month. A discussion of the estimates appears in Appendix B. The change in methodology also allowed us to estimate coverage at the sectoral level on the basis of the wage bill. In general, the proportion of wages and salaries earned by employees reported in the Employment, Payrolls and Manhours survey relative to the estimated total wage bill is even larger than the proportion of employees in the survey relative to the estimated total number of employees. Again Appendix B contains the details.

The larger-firm survey provides employment data at a fine level of industrial detail. For the manufacturing sector, employment data is disaggregated between twenty manufacturing industries at the 2-digit S.I.C. level for each province and is often further disaggregated between manufacturing industries at the 3-digit S.I.C. level. Not all of these data are publicly available as Statistics Canada withholds the data when the number of employees in an industry is very small or the number of firms in an industry is very small. For our purposes, we chose to stay at the 2-digit S.I.C. level of manufacturing detail and use the maximum number of non-confidential industries while maintaining some comparability in industries across provinces. The result was 14 manufacturing industries for Manitoba, 13 for Saskatchewan, and 15 for each of Alberta and British Columbia. The list of specific industries for each province appears in Tables 3-18 through 3-21. Availability of provincial data at such a level of manufacturing detail was a very desirable property of the database. Its absence would have necessitated turning to individual provinces to obtain manufacturing employment series and the likelihood of getting series which were consistent across provinces would have been very bleak.

The database selected had to yield data over a period long enough to reflect cyclical and medium-term structural fluctuations as well as short-term fluctuations. It was our impression that the period from 1970 to present was sufficiently long to pick up a representative collection of fluctuations. To include data prior to 1970 would be to use data bordering on being out-of-date and would necessitate a reduction in industries since employment in some would be small and would become confidential. Statistics Canada introduced major changes to the data in March 1983 and ceased presentation of the data in its historical format in April 1983. Hence the most recent continuous thirteen year period extended from April 1970 to March 1983 and this was the timeframe of the study. Over that period, there was no major break in the data and no elaborate linking mechanism, as would have been necessary with the household Labour Force Survey data, was needed.

From the point of view of its properties, data from the Employment, Payrolls and Manhours survey suited very well the requirements of our study. The only major obstacle was in accessing the data. In this age of computers and advanced technology, a researcher can become accustomed to data storage on computer tapes and to fairly immediate access to a database. In the case of the employment levels derived from this survey, however, the raw data was not so easily available. The data is compiled by the staff of Labour Division, Employment and Payrolls Section at Statistics Canada. They retain employment levels for the more-requested industries for recent years on worksheets -- gathering information from which is a straightforward enough procedure. But employment levels for the less-popular industries in recent years and for all industries in earlier years are stored on microfilm. It is a time-consuming and painstaking task to search rolls and rolls of microfilm for the relevant data. Once acquired, the data were stored on computer files where subsequent retreival and manipulation were considerably facilitated.

As a preliminary step to the analysis, the dataset had to be amended by creating an additional sector. This was done for the sake of completeness -- to ensure that the sum of employment in component sectors equalled total reported employment. A residual sector at the 1-digit S.I.C. level equal to the difference in employment at the level of the industrial composite and the sum of employment in all eight sectors was calculated for each province. In the case of Quebec, Ontario and British Columbia, the numbers in the residual sector were very small -- as they ought to have been since the sector was designed only to catch anomolies in the data. Where there were large outlying values in the time series, checks were made on the component industries and it was usually possible to reallocate employment such that the series were smoothed. When a monthly observation in the residual sector was abnormally large, for example, employment had been included in the industrial composite but had inadvertantly been omitted from a sector. In collaboration with Statistics Canada, we were able to assign the employment to a sector. The weights of the residual sector in the industrial composite of Quebec, Ontario and British Columbia were 0.010, 0.009 and 0.015 per cent, respectively. So small were these values that we decided in subsequent work to disregard this sector. In the case of Manitoba, Saskatchewan and Alberta, the weights of the residual sector were larger. This was because they included the forestry sector as well as any noise in the data. Forestry for these three individual Western provinces was confidential and consequently was not available as a separate sector. Forestry employment for the Prairie region was publicly available, however; and since the sum of employment in the residual sectors of Manitoba, Saskatchewan and Alberta approximated employment in forestry for the Prairies as a whole, we assumed the residual sector was equal to the forestry sector for each province. Noise in the residual sector was small but to the extent that it was present, the forestry sector would appear more unstable than it was in actual fact. This should be kept in mind and, in future chapters, the reader should be aware that the employment instability measures for the forestry sector will be slightly overstated for these three Western provinces. It was also due to the noise that the forestry sector was held constant for Manitoba, Saskatchewan, and Alberta in the portfolio analysis of Chapter 5.

An essential ingredient to our approach was wage and salary data comparable with the employment data. It had to cover the same set of employees, have the same industrial disaggregation, and span the same time period. Fortunately, the Employment, Payrolls and

Manhours survey provides such statistics. The questionnaire asks respondents the gross pay of wage-earners and of salaried employees, where gross pay represents pay before deductions for taxes, unemployment insurance contributions and Canada Pension Plan. It includes "salaries, straight time wages, piece-work and regular commission earnings, regular paid incentive, cost of living and other bonuses, overtime earnings and payments to persons absent with pay".[3] It does not include supplementary labour costs such as employees' contributions to unemployment insurance, medical plans, etc. Labour Division at Statistics Canada divides total gross pay of wage-earners and salaried employees by the total number of employees and by the number of weeks in the pay period. They release average weekly earnings for all employees by sector and by industry. For our purposes, monthly observations were compiled for the relevant sectors and industries and they were subsequently averaged over the 1970-1983 period. The requisite wage and salary data thus became available to us.

Extension of the Data to Include Agriculture

We noted earlier in this chapter our concern with the lack of coverage of the agriculture sector by the Employment, Payrolls and Manhours survey. A study of the Western provinces ought not to omit such an important sector and consequently we were obliged to develop employment data for agriculture and incorporate it into our main dataset. The only option open to us was the time series produced by the household Labour Force Survey. This was not in fact consistent with our existing series since there was no distinction between large and small farms and the employment levels were representative of all farms regardless of size. Neither was data available which could adequately reflect average wages and salaries in provincial agriculture. How, for example, could one account for unpaid family workers within the agricultural employment series? Another difficulty was with the break in LFS data in 1975.

We proceeded, nonetheless, to include agriculture within our data set. We began by adjusting for the discontinuity in 1975. Although Statistics Canada has not linked data from the old and new Labour Force Survey at the sectoral level for the provinces, they have done so for the Canada total level. More particularly, for Canadian agriculture, they have used the twelve overlapping monthly observations of 1975, when the old and new surveys were run simultaneously, to get twelve adjustment factors. The adjustment factors were applied to the historical data to scale it to the more recent data. There were other methods of linking the series but since Statistics Canada had adopted this method at the aggregate level, we used it at the level of the provinces. The resulting agriculture time series ran from April 1970 to March 1983. We multiplied each provincial series by one thousand to correct for the rounding of the LFS data and we concantenated them with the larger-firm survey database. Subsequent chapters describe our use of the extended database. The limitations of the

LFS data, especially the absence of comparable wage data, the break in 1975, and the rounding of numbers, plus the inconsistency between concepts of LFS data and larger-firm survey data prevented us from doing the full analysis on the amended database.

The employment data derived from the Employment, Payrolls and Manhours survey was clearly the most appropriate for our analysis. It was available monthly, in actual unrounded figures, by province, at a reasonable level of disaggregation for the manufacturing sector, over a suitably long period of time and had associated average weekly earnings data. No other database met all of these requirements. Our analysis exhausted the data from the Employment, Payrolls and Manhours survey.

Notes

1 Employment, Earnings and Hours, Statistics Canada catalogue #72-002.

2 The list of examples could be endless and we do not wish to belabour the point, but it might be interesting to illustrate from the business services and miscellaneous services industries. Operations within service to business management which may in some cases exceed twenty employees and in other cases fall short include advertising agencies, engineering services and accounting services. Within miscellaneous services, office cleaning and the Red Cross Society could have more than twenty employees while blacksmith shops and knife and scissor sharpening shops are likely to have fewer than twenty. The implications for the collection of data from these types of activity would be as described in the text.

3 Employment, Earnings and Hours, Statistics Canada catalogue #72-002.

Table 2-1

Larger-Firm Survey Employment as a Percentage of Total Estimated Employment, 1972 and 1978, Six Provinces

Industry	1972						1978					
	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Forestry	..	..	..	..	..	..	92	86	-----	76	-----	74
Mining	97	94	99	93	91	81	95	91	98	94	82	92
Manufacturing	90	92	90	79	84	90	88	90	89	77	80	86
Construction	..	..	..	..	..	..	52	50	51	39	46	40
Trnsp, Comm, & Utilities	90	87	96	87	85	86	90	87	92	88	84	86
Trade	54	63	65	51	61	60	55	61	64	55	58	56
F.I.R.E.	76	82	86	73	76	71	74	76	78	72	68	70
Commercial Services	48	56	52	36	54	47	52	52	54	39	52	46
Industrial Composite	73	74	75	62	69	70	72	73	74	61	64	66

Source: Employment, Earnings and Hours, Statistics Canada catalogue #72-002.

Chapter 3: DESCRIPTION OF WESTERN CANADA MANUFACTURING SECTORS

This chapter provides much of the data that serves as the statistical base for analysis in later chapters. The approach here is largely descriptive, but some exercises are also included to give the reader a "feeling" for the data and the shape of things to come. It should be noted that this chapter is not restricted to manufacturing or even to Western Canada. As already stated in Chapter 1, it is important to put manufacturing in the context of the provincial economies as a whole and some significant comparisons are made with the corresponding situations in the two Central Canada provinces. In this chapter the various pieces of statistical data are described rather separately and, it may seem, that the data have no essential connections. In the following chapters, particularly Chapter 5, all the pieces "come together" in a very essential way. Finally we remark that the present chapter contains many tables; it is possible to show even more tables, but only the important and most relevant tabular data are formally presented in the study. Where other data or tabulations are available that may interest some readers, this will be indicated.

Aggregative View of the Provincial Economies

As a preliminary, we first consider the four Western Canada and the two Central Canada provinces as a whole from the viewpoint of our data base. The choice of prime data base, namely the larger-firm employment survey covering the monthly time period April 1970 to March 1983, has already been discussed in the previous chapter and will not be further discussed here (although some essential aspects of the choice are again mentioned). Some important tabular results are also shown, however, using an alternative and extended data base.

The data base directly or indirectly yields four statistical measures that permeate the study. Three of the measures are easy to describe; the fourth measure is somewhat complicated. The first measure is simply the average total labour employed during the relevant time period for the provincial economy (with reference to the particular data base). When the provincial economy is disaggregated by industry, we will be concerned with the average total labour employed in each industry, usually indicated by the employment weight of each industry relative to the provincial-wide employment of all industries in the data base. Since this section is restricted to an aggregate view, the implicit weight is identically equal to unity and we will show figures for actual average total labour employed. The second measure is the average annual (compound) growth rate of total labour employed over the relevant time period. The measure (methodology) is essentially the same whether the subject is the provincial economy or whether we are concerned with individual sectors (or industries) within the provincial economies. A third measure is simply the average weekly wage and salary level of the total labour employed, with the average taken over the time period of the data base. This measure is in current averaged dollars and no attempt is made (nor needed) to adjust for wage inflation.

Table 3-1 exhibits the three measures for each of the six Canadian provinces. All tables in this chapter are based on the larger-firm survey introduced in the previous chapter, unless otherwise specifically indicated. The figures in Table 3-1 are slightly rounded, for convenience of presentation, but unrounded figures are actually used in later computations. The results of this table are not particularly surprising to anyone acquainted with the Canadian provincial economies and their recent economic experiences. The various figures serve mainly as a reference point of departure for later analysis. Our prime interest, of course, is in the four Western provinces with the two Central provinces serving as a basis for comparison.

It was mentioned earlier that there are four fundamental statistical measures, only three of which have been described. The fourth measure is by far the most important for the purposes of this study. This critical measure concerns employment instability over the relevant time period. The derivation of the measure is as follows.[1] First we fit a nonlinear (quadratic) trend to monthly employment observations over the 1970-83 period for the provincial economy. The deviations of actual employment from trend are collected, squared (to eliminate the distinction between positive deviations and negative deviations) and then the squared deviations are all averaged over the 156 observations (the number of months in 13 years). The resulting figure is a kind of statistical variance around a moving "mean". Finally we take the square root of this variance, which yields a kind of statistical standard deviation, and divide by the average total labour employed during the relevant time period. The division operation is needed in order to scale the standard deviation for comparative purposes.2 The final figure is then a kind of statistical coefficient of variation. The measure, when multiplied by 100, roughly indicates the typical overall percentage (absolute) deviation of provincial monthly employment fluctuations around trend relative to the typical overall level of employment. It is for this reason that the measure serves as an indication of employment instability.

The first column of Table 3-2 shows the indicated measure of employment instability (before multiplication by 100) for the six provinces. These results are new and, perhaps, not well-known. It is clear, at least based on the larger-firm survey, that the Western provinces experience a greater degree of employment instability compared to the Central provinces. There is a particularly large gap between the situation in Alberta (employment instability equal to .0542) and that in Ontario (employment instability of .0292). A number of possible objections could be raised concerning these measures. It may be argued that the measures are too sensitive to strictly random and seasonal fluctuations around trend, because they are based on monthly observations. This objection is potentially valid since we wish our measure of employment instability to reflect cyclical (medium-term) variations and structural (long-term) variations around the longer-term trend of 13 years, as well as short-term variations. Therefore the measures of provincial employment instability were recalculated using two-month average observations (a total of 78 observations based on 6 per year) and also using three-month average observations (a total of 52 observations). The results, shown in the second and third columns of Table 3-2, are clear; most measures decrease slightly as the unit observation interval increases, but the important provincial comparisons are virtually unaffected.3 In order, however, to abstract from strictly random and seasonal influences (very short-term) all the employment instability measures of this study are based on observations coming from two-month averages. We also maintain that the time period 1970-83, is sufficiently long to embody medium-term and structural employment fluctuations as well as short-term variations. Before continuing it might be noted that the three statistical measures given previously in Table 3-1 are entirely unaffected by monthly changes in the unit observations.

A more severe objection to the measures embodied in Table 3-2 concerns the incomplete coverage of the larger-firm employment survey. This point is discussed at length in Chapter 2. There it was pointed out that the larger-firm survey is the only Canadian labour data base capable of satisfying the long-term data consistency requirements of this study at the monthly and provincial levels while, at the same time, yielding a reasonable disaggregation level for an analysis of Western Canada manufacturing. It is, nevertheless, of definite interest to calculate provincial employment instabilities on the basis of the alternative household labour survey (mentioned in Chapter 2). This has been done using a statistical procedure identical to that used for Table 3-2 (mid-column) and the results for two distinct time periods, 1966-74 and 1975-83, are shown in Table 3-3. These measures do differ considerably from those presented in Table 3-2 and so some further discussion is called for.

It is apparent, from the household labour survey, that the four Western provinces are not typically more unstable in terms of employment compared to the two Central provinces. This result at least holds for the two time periods 1966-74 and 1975-83 (particularly the latter period). The results are important in view of the "universal" coverage claimed by the household survey (see Chapter 2). The two distinct time periods, however, are not sufficiently long to "catch" significant structural employment fluctuations around trend; the break year 1975 probably is unfortunate for our purposes.4 There is, then, the possibility that a longer time period (say 13 years), also possessing universal coverage, might produce measures of employment instability different than those in Table 3-3. We also know that the household labour survey is a relatively poor source of employment data (being really oriented to unemployment rather than employment) and that all data are affected by sampling error and come "rounded" to the nearest thousand (Chapter 2). In any event, because the prime orientation of this study is towards the Western manufacturing sectors, we must proceed with the larger-firm survey. It should, nevertheless, be kept in mind that the main comparative results of Table 3-2 (i.e., the fact that Western provincial employment instability is typically greater than employment instability in Central Canada) is limited to the coverage embodied in the larger-firm survey, namely the non-agricultural incorporated business sector of the provincial economies.

Before closing this issue, some further work was done in order to observe the impact of extending the coverage in Table 3-2. We know that agricultural employment is important for the Western provinces, particularly Saskatchewan. Agriculture is not covered by the larger-firm survey, but this sector is part of the household survey. By using a procedure outlined in Chapter 2, we managed to yield a provincial monthly time series of agricultural employment for the full time period 1970-83 (i.e., the 1975 break was "eliminated" by an adjustment procedure). This time series was then simply added to the provincial-wide non-agricultural employment time series from the larger-firm survey and provincial employment instabilities were then measured using the extended coverage (based, again, on two-month average observations). The new results are shown in the first column of Table 3-4 and easily compared to the unextended results (second column). It is clearly evident that the inclusion of agricultural employment widens the "gap" between the Western provinces and the two Central provinces in terms of employment instability; Saskatchewan is now the province exhibiting the greatest degree of employment instability (.0637) closely followed by Alberta (.0611). The inclusion of agriculture actually makes all provinces more unstable, largely depending on the relative importance of agricultural employment, except for British Columbia.[5] We, nevertheless, proceed in this study without agriculture since the sector's employment time series is not consistent with that of the non-agricultural sector and, also important, it is very difficult to measure agricultural average wage levels needed for the more advanced analysis of Chapter 5.

Comparison of Manufacturing with Other Sectors

All the tabular results of the previous section are with respect to the provincial economies as a whole (usually with larger-firm survey coverage). We now show the sectoral disaggregation of these results with special emphasis on the manufacturing sector. First consider the set of Tables 3-5 to 3-10 inclusive giving sectoral employment growth rates and average weekly wage levels for the individual sectors covered in this study, each table representing one of the six provinces. It is now evident that the larger-firm survey covers eight distinct sectors (see Chapter 2 for more discussion) one of which is manufacturing (sector no. 3). Since manufacturing is later analyzed in the context of the whole provincial economies, it is useful to compare employment growth rates and average wage levels in manufacturing with the corresponding estimates for other sectors. Our main concern, of course, is the four Western provinces, but the comparative situation in Québec and Ontario is also of some interest. All figures in the six tables are merely the sectoral disaggregation of the provincial-wide results originally presented in Table 3-1 (second and third columns). Thus, for example, it is easy to see that the Manitoba manufacturing employment growth rate from Table 3-7 (namely 0.4 per cent) is less than the Manitoba employment growth rate for all sectors taken together (Table 3-1, namely 0.9 per cent). Indeed this particular relationship holds true for the six provinces, and not only for Manitoba. Further observation confirms that the employment growth rates for the manufacturing sectors in the four Western provinces are all greater than the corresponding growth rates experienced by the two Central provinces. The "gap" in this case between Alberta (3.1 per cent and Québec (-0.8 per cent) is especially large.

Analogous comparative observations can be made with regard to average weekly wage levels. There are wide sectoral differences in average wage levels (1970-83) within each province; manufacturing sector wage levels are typically close to the average wage levels for the provinces' as a whole, though there are some exceptions (e.g., British Columbia). It is rather tedious to work out all possible comparisons -- the purely descriptive approach of this chapter has its limitations. Clearly some analytical method is needed to put everything together in a meaningful context and this is precisely what is done in Chapter 5. Nevertheless the underlying observations are of some interest per se and it is also immediately possible to express some elementary analysis. This is done by considering the next set of six Tables 3-11 to 3-16 inclusive.

Each table shows, in the first column, the percentage employment weight for the individual sectors covered by the larger-firm survey (each table, again, representing one of the six provinces). The sectoral employment weights merely indicate the percentage distribution of the (average) provincial employment level for the time period concerned, the distribution being over the eight non-agricultural incorporated business sectors. Since the weights are expressed in percentage terms, the employment weights in each table sum to 100 per cent. By using the sectoral employment weights in conjunction with the average overall provincial employment levels in the original Table 3-1 (first column), it is possible to estimate average (1970-83) sectoral employment levels within each province and do this for all eight sectors. Nevertheless, it is of critical importance for this study to preserve the sectoral (percentage) employment weights.[6] We see that the manufacturing sectoral employment dominates in Québec and Ontario (about 42 per cent). Manufacturing is relatively less important, in terms of employment weight, within the four Western provinces compared to the two Central provinces, but there are significant differences among the four Western provinces in this respect. Among the Western provinces, the manufacturing sector employment weight is greatest in British Columbia and Manitoba (28.5 per cent and 25.4 per cent respectively) and smallest in Saskatchewan and Alberta (15.1 per cent and 16.6 per cent). On the other hand the sectoral employment weights of mining, transportation & communication & utilities, and trade are typically and significantly larger in the four Western provinces compared to Central Canada. Once again many more such descriptive comparisons can be performed, but tend to be tedious without an analytical direction.

It was mentioned earlier that some elementary analysis is immediately possible. The sectoral employment weights, when normalized to sum to unity, serve as a direct intermediary between provincial-wide employment growth rates and (average) wage levels, on the one hand, and their provincial disaggregated sectoral counterparts, on the other hand. Indeed it is easy to show that the provincial-wide employment growth rates of Table 3-1 are each a weighted average of the respective provincial sectoral employment growth rates of Tables 3-5 to 3-10, with the weights coming directly form the corresponding sectoral employment weights of Tables 3-11 to 3-16 respectively.[7] A completely analogous relationship holds with respect to provincial (average) weekly wage levels and their sectoral disaggregation.[8] These simple analytical relationships will play a key role in putting all the analysis together in Chapter 5. We will also note the critical importance of when such elementary relationships do not hold with respect to another statistical measure to be discussed presently.

The second column of Tables 3-11 to 3-16 displays the sectoral employment instability measures for each of the eight distinct sectors in each province. The methodology for producing the sectoral instability measures is identical to that used in the earlier Table 3-2 (mid-column) where the provincial-wide measures of employment instability are shown. Each particular sectoral measure indicates what the overall provincial employment instability measure would be _if_ provincial employment were all concentrated in one sector. In reality, of course, the provincial instability measures of Table 3-2 _reflect_ each and every sectoral employment instability measure of the corresponding Tables 3-11 to 3-16 (second column). We will see that the "reflection" mechanism is rather complex and, indeed, not fully described by the preceding statement. At this point, however, it is interesting to compare the relative magnitudes of the sectoral instability measures with particular emphasis on manufacturing. The reader should observe that the sectoral measures display a remarkable pattern of similarity across the different provinces. In almost all cases, the manufacturing employment instability is considerably less than that of forestry, mining and construction and also often less than the employment instability of commercial services. In the Western provinces, and also in Central Canada, the transportation & communication & utilities (TCU) sector, the trade sector, and the finance & insurance & real estate (FIRE) sector usually experience the least employment instability according to our measure (Manitoba is an exception where the manufacturing sector employment is more stable than that of any other sector within that province). These general pattern similarities are remarkable because the individual sectoral output and employment compositions can differ considerably from province to province.

One of the most important results of the previous section concerned the relative magnitudes of provincial-wide employment instability (Table 3-2). There it was shown that Western provinces (particularly Alberta) exhibit greater employment instability compared to Central provinces (particularly Ontario). We should, at first glance, expect similar results to show up at the sectoral comparison level. Indeed, with the exception of the forestry sector, each of Alberta's sectoral employment instabilities is greater than the corresponding magnitude for Ontario. It is perfectly possible to perform many other such comparisons, thought the "results" are not always clear cut. In fact it is easy to imagine that the simple analytical relationship based on sectoral employment weights, mentioned earlier in this section, might also hold true with respect to the measure of employment instability. In this case, though, "imagination" is a poor guide. It is not generally true that provincial-wide employment instability (Table 3-2) is a weighted average of the respective provincial sectoral employment instability measures (Tables 3-11 to 3-16, second column) with the weights coming from the corresponding sectoral employment weights (normalized) of the latter tables (first column). A quick counter-example to show that the simple analytical relationship does not hold can be immediately obtained by observing that the Manitoba employment instability measure equals .0337 (Table 3-2) and that this figure is *less than* the instability measures shown in Manitoba Table 3-13 for each and every sector within the province. Clearly, then, while it is true that provincial-wide employment instability reflects the province's sectoral instabilities, the reflection is complex and embodies other elements as well. Most important, provincial-wide employment growth (and average wage levels) are internally *bound* by the corresponding sectoral employment growth rates (and sectoral wage levels); it can never happen that the provincial-wide employment growth rate is greater than that of each and every sector within the province. On the other hand, it is possible (and, indeed, rather common depending on disaggregation) for provincial-wide employment stability[9] to be greater than employment stability experienced by each and every sector within the province. These matters really require further discussion and illustration; this is the subject-matter of Chapter 4.

To close this section we reconsider the impact of including agriculture employment in the provincial employment instability measures (see again Table 3-4). If agricultural employment is simply added to the employment coverage of the larger-firm survey, there would be a dramatic change in the sectoral employment weights for some provinces. The first column of Table 3-17 shows the derived employment weight for the agricultural sector in the extended case. This would mean, for example, that agricultural employment in the province of Saskatchewan comprises over 50 per cent of total provincial employment covered by agriculture and the non-agricultural incorporated business sectors together. Agriculture is also relatively important in Manitoba and Alberta; the sector is actually less important in British Columbia compared to Québec and Ontario according to our measures. The second column of Table 3-17 displays the employment instability measure for agriculture in each province. The measures are reasonably similar in magnitude and reminiscent of the employment instability magnitudes for the provincial construction sectors shown earlier. In any event, the impact of agriculture is to usually raise provincial-wide employment instability, particularly for Saskatchewan because of the sector's relative employment weight in that province. It is, nevertheless, curious to observe that the inclusion of agriculture employment in British Columbia actually lowers that province's employment instability even though British Columbia's agricultural sector is more unstable than that of any other province. This is one more symptom that "something" is missing from our conceptual transcription of employment instability and that further consideration is required.

A Disaggregated View of the Western Manufacturing Sectors

The prime emphasis of this study is the manufacturing sectors of the Western Canada provinces. The motivation of this emphasis was given in Chapter 1. Manufacturing, however, is a heterogeneous sector and it becomes important to draw distinctions within manufacturing, i.e., to show an industrial disaggregation of manufacturing. This section, then, is concerned with describing and presenting statistical measures that underlie an industrial disaggregation of those measures given for the manufacturing sector as a whole in the previous section. Since no new descriptive concepts or new elementary analysis is involved, this section is brief. The disaggregated view, presented in the tables to follow, is essential for later analysis in the study. One further point should be made. In this section we only show tabular data for the Western provinces' manufacturing. The reader, though, might be interested in knowing that a similar disaggregation (in fact, at an even finer level) is also available for Québec and Ontario and can be obtained from the authors on request.[10]

The disaggregated view of Western Canada manufacturing consists of two sets of tables, Tables 3-18 to 3-21 and Tables 3-22 to 3-25. It will be seen that the industrial disaggregation of the manufacturing sectors is not quite the same in each of the Western provinces, depending mainly on confidentiality limitations (discussed in Chapter 2). Fifteen industries are "distinguished" for Alberta and British Columbia; in Manitoba and Saskatchewan there are fourteen and thirteen manufacturing industries respectively. The residual manufacturing "industry" in both Alberta and British Columbia comprises tobacco products, rubber & plastic products, leather products, textiles, knitting mills and miscellaneous manufacturing. For Manitoba, residual manufacturing also includes petroleum & coal products (too small to be distinguished for that province); for Saskatchewan, residual manufacturing also includes non-metallic mineral products and furniture & fixtures, but not petroleum & coal products. Thus the composition of residual manufacturing is diverse and varies, to some extent, from province to province. On the other hand, all other manufacturing industries are "comparable" from province to province. It is also convenient to note that industries no. 1 and 2 for each province, namely food & beverages and printing & publishing are sometimes called "local manufacturing" because a relatively large proportion of the industries' outputs are typically consumed within the respective provinces.[11] A next set of manufacturing industries, namely wood products, paper & allied industries, primary metals, non-metallic mineral products, and petroleum & coal products, are commonly referred to as "primary manufacturing". Then the remaining industries that are specifically distinguished, namely clothing, furniture & fixtures, metal fabricating, machinery, transportation equipment, electrical products, and chemical products, are all components of "secondary manufacturing". The classification of the manufacturing sector into these three sub-sectors plays a key role in some analytical exercises performed in Chapter 5. Note that residual manufacturing actually contains a "mixture" of primary and secondary manufacturing industries.

The first set of Tables 3-18 to 3-21 provides the industrial disaggregation of the manufacturing sector employment growth rates and average weekly wage and salary levels (1970-83) originally shown in Tables 3-7 to 3-10 (line 3). In fact, for the reader's convenience, the latter information is repeated in the new set of tables as "total manufacturing" (last line of Tables 3-18 to 3-21). We could now see that total manufacturing sector employment growth rates and wage levels conceal a wide variety of growth rates and wage levels on the individual manufacturing industry basis. There are some patterns of similarity across the different Western provinces. For example, the employment growth rate of food & beverages is usually low relative to those of other industries in the same province; the machinery manufacturing industry displays relatively high employment growth rates in each province. Similarly, the average wage and salary level for the clothing industry is uniformly and significantly lower than that of any other industry distinguished in the tables and this relationship holds for each province. On the other hand, the wage levels earned in paper & allied industries and petroleum & coal products are typically the highest in each province's manufacturing sector. It is also easy to find differences in pattern from province to province. Once again a case can be made for constructing an analytical framework sufficiently powerful to put everything together -- and this will be done.

Turning now to the other set of Tables 3-22 to 3-25, we have the industrial disaggregation counterpart of the manufacturing sector employment weights and instability measures originally shown in Tables 3-13 to 3-16 (line 3) and now repeated as "total manufacturing" (last line of new set of tables). There is, however, one important difference. The employment weights of Tables 3-22 to 3-25 do not sum to 100 per cent, but merely sum to the employment weight of the respective provincial manufacturing sector. In effect, therefore, the manufacturing industry employment weights do not measure (relative) employment distribution within the manufacturing sectors as they would do _if_ the measures were transformed to sum to 100 per cent. This means that the displayed employment weights cannot be used to perform the simple analytical exercises mentioned in the previous section. If one wishes to show analogously, that the employment growth rate for total manufacturing equals an (employment) weighted average of the employment growth rates for the constituent manufacturing industries, then the employment weights must first be transformed (by simple proportionality) to sum to 100 per cent and then normalized to add to unity. Completely analogous remarks apply to the other statistical measure average wage and salary levels. We prefer to show manufacturing industry employment weights that sum to the original manufacturing sector employment weight, in order to serve as a _reminder_ that manufacturing, in this study, is ultimately analyzed in the context of the provincial economies as a whole. The employment weights in Tables 3-22 to 3-25 do indicate some inter-provincial similarities and differences with respect to manufacturing employment composition. Food & beverages is always a relatively important industry in terms of employment within the provincial manufacturing sectors. Manitoba's clothing industry (employment weight equal to 3.4 per cent) certainly stands out followed by transportation equipment (2.8 per cent). Neither Saskatchewan nor, suprisingly, Alberta possess individual manufacturing industries of outstanding relative employment importance, with the exception of food & beverages. It is not surprising to learn that British Columbia's manufacturing employment is dominated by wood products and paper & allied industries.

Tables 3-22 to 3-25 also show instability measures for the individual manufacturing industries (second column). Within each Western province, the measures display a considerable range of magnitudes showing that at least some disaggregation of manufacturing is essential for our purposes.[12] Once again there are some similarities and differences across provinces. Food & beverages and printing & publishing are usually relatively stable sources of employment and so are clothing and chemical products in most provinces. Wood products, petroleum & coal products and machinery are typically unstable sources of employment according to our statistical measures and coverage. Some industries such as electrical products and transportation equipment exhibit no pattern of similarity across provinces in terms of employment stability. It should be noted, though, that the output composition of specific manufacturing industries can differ greatly from province to province even if the industries are classified by the same official name. Also, individual employment instability measures are affected by the magnitude of the (average) employment level embodied in particular industries and this point[13] appears to carry some weight in the case of Saskatchewan (Table 3-23). Most important, the new set of Tables displays a phenomenon emphasized in the previous section: the employment instability measure for total manufacturing (last line of tables) is typically lower than that of all (Manitoba) or almost all (Saskatchewan, Alberta, British Columbia) the instability measures for the component manufacturing industries. The employment weighted average analysis does not "work" with respect to the employment instability concept and a more sophisticated analysis is required to expose the relationship between aggregate and disaggregated entities.

Notes

1 A more technical derivation can be found in Appendix A together with discussion of desirable properties.

2 This is particularly desirable in view of the wide disparity of employment levels in the six provinces.

3 Almost all of the results from the more disaggregated and advanced analysis to follow are also unaffected by choice of unit observation (e.g., individual components of the correlation matrices shown in Chapter 4).

4 The larger-firm survey was also used to estimate provincial employment instability for the period 1975-83. These estimates clearly show the importance of the 1975 break since most Western provinces (particularly Alberta) exhibit greater employment instability when measured over the full time period 1970-83 compared to measurements over the shorter period 1975-83.

5 This phenomenon is discussed again in the next section and further clarified in Chapter 4.

6 This will become more apparent in later chapters, but is also evident later in this chapter.

7 See Appendix A for a more precise discussion particularly with regard to an approximation error in this relationship and the means for treating the subject.

8 This relationship is not subject to approximation error; see Appendix A.

9 One might call employment stability to be the inverse of employment instability.

10 See also comments in Chapter 1 on the possibility of running economic diversification analyses for other provinces and even sub-provincial areas aside from the four Western Canada provinces.

11 Food & beverages is affected by perishibility factors; printing & publishing often caters to regional information requirements.

12 This theme is pursued at greater length in Chapters 4 and 5 of the study.

13 A more technical discussion turns up in Chapters 5 and 6.

Table 3-1

Provincial Employment Level, Employment Growth Rate and Average Weekly Wage Level, 1970-1983, Six Provinces

Province	Employment Level	Employment Growth Rate	Wage Level
	(no. employed)	(per cent)	(current $)
Québec	1,085,640	0.6	230
Ontario	1,832,900	1.7	235
Manitoba	185,970	0.9	211
Saskatchewan	99,230	3.3	219
Alberta	336,640	5.9	247
British Columbia	441,740	2.4	266

Table 3-2

Measure of Provincial Employment Instability, One-Month, Two-Month and Three-Month Averages, 1970-1983, Six Provinces

Province	One-Month	Two-Month	Three-Month
Québec	.0334	.0328	.0313
Ontario	.0292	.0287	.0284
Manitoba	.0344	.0337	.0328
Saskatchewan	.0419	.0409	.0400
Alberta	.0542	.0541	.0537
British Columbia	.0429	.0416	.0415

Table 3-3

Measure of Provincial Employment Instability, Household Labour Survey, 1966-1974 and 1975-1983, Six Provinces

Province	1966-1974	1975-1983
Québec	.0355	.0384
Ontario	.0252	.0296
Manitoba	.0343	.0299
Saskatchewan	.0501	.0382
Alberta	.0330	.0319
British Columbia	.0299	.0360

Table 3-4

Measure of Provincial Employment Instability, With and Without Agriculture, 1970-1983, Six Provinces

Province	With Agriculture	Without Agriculture
Québec	.0347	.0328
Ontario	.0324	.0287
Manitoba	.0416	.0337
Saskatchewan	.0637	.0409
Alberta	.0611	.0541
British Columbia	.0408	.0416

Table 3-5

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Québec

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	-0.9	267
2. Mining	-1.4	314
3. Manufacturing	-0.8	232
4. Construction	-3.4	345
5. Transp'n, Comm'n, Utilities	0.9	274
6. Trade	1.8	182
7. Finance, Insurance, Real Estate	2.9	226
8. Commercial Services	4.7	169

Table 3-6

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Ontario

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	2.6	306
2. Mining	-1.4	313
3. Manufacturing	0.3	258
4. Construction	-2.5	331
5. Transp'n, Comm'n, Utilities	2.1	279
6. Trade	2.6	174
7. Finance, Insurance, Real Estate	4.2	229
8. Commercial Services	5.5	163

Table 3-7

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Manitoba

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	1.3	268
2. Mining	-3.8	304
3. Manufacturing	0.4	214
4. Construction	-5.1	303
5. Transp'n, Comm'n, Utilities	0.5	262
6. Trade	1.4	167
7. Finance, Insurance, Real Estate	3.6	211
8. Commercial Services	3.4	138

Table 3-8

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Saskatchewan

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	0.2	269
2. Mining	5.0	317
3. Manufacturing	1.7	249
4. Construction	0.7	292
5. Transp'n, Comm'n, Utilities	1.3	264
6. Trade	3.8	170
7. Finance, Insurance, Real Estate	6.4	214
8. Commercial Services	6.4	124

Table 3-9

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Alberta

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	2.4	268
2. Mining	8.9	374
3. Manufacturing	3.1	267
4. Construction	5.3	345
5. Transp'n, Comm'n, Utilities	4.9	277
6. Trade	5.7	186
7. Finance, Insurance, Real Estate	8.4	222
8. Commercial Services	7.8	156

Table 3-10

Sectoral Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, British Columbia

Sector	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Forestry	-0.5	336
2. Mining	2.5	348
3. Manufacturing	0.7	296
4. Construction	0.7	398
5. Transp'n, Comm'n, Utilities	2.2	300
6. Trade	2.8	212
7. Finance, Insurance, Real Estate	5.8	230
8. Commercial Services	5.3	169

Table 3-11

Sectoral Employment Weights and Instability Measures, 1970-1983, Québec

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	1.2	.319
2. Mining	2.1	.088
3. Manufacturing	42.0	.035
4. Construction	4.3	.122
5. Transp'n, Comm'n, Utilities	16.3	.029
6. Trade	16.2	.030
7. Finance, Insurance, Real Estate	7.3	.032
8. Commercial Services	10.6	.043

Table 3-12

Sectoral Employment Weights and Instability Measures, 1970-1983, Ontario

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	0.5	.206
2. Mining	1.7	.092
3. Manufacturing	42.9	.034
4. Construction	4.4	.103
5. Transp'n, Comm'n, Utilities	12.1	.026
6. Trade	18.3	.027
7. Finance, Insurance, Real Estate	7.9	.022
8. Commercial Services	12.2	.043

Table 3-13

Sectoral Employment Weights and Instability Measures, 1970-1983, Manitoba

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	0.5	.209
2. Mining	3.4	.072
3. Manufacturing	25.4	.037
4. Construction	4.2	.134
5. Transp'n, Comm'n, Utilities	23.5	.045
6. Trade	22.9	.043
7. Finance, Insurance, Real Estate	7.3	.043
8. Commercial Services	12.8	.044

Table 3-14

Sectoral Employment Weights and Instability Measures, 1970-1983, Saskatchewan

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	0.6	.208
2. Mining	6.4	.089
3. Manufacturing	15.1	.048
4. Construction	5.6	.186
5. Transp'n, Comm'n, Utilities	24.7	.045
6. Trade	26.4	.035
7. Finance, Insurance, Real Estate	8.8	.041
8. Commercial Services	12.4	.053

Table 3-15

Sectoral Employment Weights and Instability Measures, 1970-1983, Alberta

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	0.5	.178
2. Mining	9.9	.098
3. Manufacturing	16.6	.051
4. Construction	8.9	.142
5. Transp'n, Comm'n, Utilities	18.1	.039
6. Trade	22.4	.045
7. Finance, Insurance, Real Estate	7.6	.049
8. Commercial Services	15.9	.065

Table 3-16

Sectoral Employment Weights and Instability Measures, 1970-1983, British Columbia

Sector	Employment Weight	Instability Measure
	(per cent)	
1. Forestry	3.5	.137
2. Mining	3.0	.078
3. Manufacturing	28.5	.063
4. Construction	4.7	.136
5. Transp'n, Comm'n, Utilities	19.9	.039
6. Trade	19.2	.049
7. Finance, Insurance, Real Estate	7.6	.032
8. Commercial Services	13.5	.051

Table 3-17

Agriculture Sectoral Employment Weight and Instability Measure, 1970-1983, Six Provinces

Province	Employment Weight	Instability Measure
	(per cent)	
Québec	6.4	.128
Ontario	6.5	.120
Manitoba	17.7	.117
Saskatchewan	50.2	.107
Alberta	22.9	.159
British Columbia	4.2	.176

Table 3-18

Manufacturing Industry Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Manitoba

Industry	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Food & Beverages	-1.1	227
2. Printing & Publishing	0.5	221
3. Wood Products	3.1	200
4. Paper & Allied Industries	1.8	257
5. Primary Metals	2.8	262
6. Non-Metallic Mineral Products	0.6	259
7. Clothing	-0.8	134
8. Furniture & Fixtures	0.4	182
9. Metal Fabricating	0.3	238
10. Machinery	3.9	223
11. Transportation Equipment	2.5	222
12. Electrical Products	1.4	224
13. Chemical Products	1.5	236
14. Residual Manufacturing	-0.6	186
Total Manufacturing	0.4	214

Table 3-19

Manufacturing Industry Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Saskatchewan

Industry	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Food & Beverages	-1.2	241
2. Printing & Publishing	2.6	230
3. Wood Products	2.6	246
4. Paper & Allied Industries	0.5	353
5. Primary Metals	3.8	284
6. Petroleum & Coal Products	-5.1	318
7. Clothing	1.6	133
8. Metal Fabricating	4.7	269
9. Machinery	6.4	223
10. Transportation Equipment	3.2	236
11. Electrical Products	7.9	220
12. Chemical Products	2.1	263
13. Residual Manufacturing	3.7	253
Total Manufacturing	1.7	249

Table 3-20

Manufacturing Industry Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, Alberta

Industry	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Food & Beverages	1.8	245
2. Printing & Publishing	6.6	251
3. Wood Products	-1.5	234
4. Paper & Allied Industries	4.5	290
5. Primary Metals	2.8	299
6. Non-Metallic Mineral Products	4.7	299
7. Petroleum & Coal Products	10.6	352
8. Clothing	0.2	174
9. Furniture & Fixtures	0.8	212
10. Metal Fabricating	3.8	286
11. Machinery	7.3	290
12. Transportation Equipment	-1.7	247
13. Electrical Products	3.5	244
14. Chemical Products	6.9	327
15. Residual Manufacturing	2.5	268
Total Manufacturing	3.1	267

Table 3-21

Manufacturing Industry Employment Growth Rates and Average Weekly Wage Levels, 1970-1983, British Columbia

Industry	Employment Growth Rate	Wage Level
	(per cent)	(current $)
1. Food & Beverages	0.7	256
2. Printing & Publishing	2.6	263
3. Wood Products	-0.1	294
4. Paper & Allied Industries	1.5	354
5. Primary Metals	0.7	322
6. Non-Metallic Mineral Products	0.6	302
7. Petroleum & Coal Products	1.8	361
8. Clothing	2.2	152
9. Furniture & Fixtures	-2.5	253
10. Metal Fabricating	0.4	304
11. Machinery	2.8	307
12. Transportation Equipment	2.4	305
13. Electrical Products	-0.3	279
14. Chemical Products	-0.0	282
15. Residual Manufacturing	-0.2	237
Total Manufacturing	0.7	296

Table 3-22

Manufacturing Industry Employment Weights and Instability Measures, 1970-1983, Manitoba

Industry	Employment Weight	Instability Measure
	(per cent)	
1. Food & Beverages	5.1	.039
2. Printing & Publishing	1.9	.050
3. Wood Products	0.8	.090
4. Paper & Allied Industries	1.1	.039
5. Primary Metals	1.4	.083
6. Non-Metallic Mineral Products	0.6	.119
7. Clothing	3.4	.053
8. Furniture & Fixtures	0.8	.088
9. Metal Fabricating	2.2	.077
10. Machinery	2.1	.129
11. Transportation Equipment	2.8	.092
12. Electrical Products	1.0	.044
13. Chemical Products	0.5	.073
14. Residual Manufacturing	1.6	.039
Total Manufacturing	25.4	.037

Table 3-23

Manufacturing Industry Employment Weights and Instability Measures, 1970-1983, Saskatchewan

Industry	Employment Weight	Instability Measure
	(per cent)	
1. Food & Beverages	5.0	.055
2. Printing & Publishing	1.2	.034
3. Wood Products	1.3	.083
4. Paper & Allied Industries	0.6	.115
5. Primary Metals	1.5	.115
6. Petroleum & Coal Products	0.5	.112
7. Clothing	0.6	.109
8. Metal Fabricating	1.1	.112
9. Machinery	1.2	.152
10. Transportation Equipment	0.4	.233
11. Electrical Products	0.5	.230
12. Chemical Products	0.3	.138
13. Residual Manufacturing	1.1	.132
Total Manufacturing	15.1	.048

Table 3-24

Manufacturing Industry Employment Weights and Instability Measures, 1970-1983, Alberta

Industry	Employment Weight	Instability Measure
	(per cent)	
1. Food & Beverages	4.1	.046
2. Printing & Publishing	1.0	.060
3. Wood Products	1.4	.075
4. Paper & Allied Industries	0.6	.075
5. Primary Metals	1.0	.097
6. Non-Metallic Mineral Products	1.3	.101
7. Petroleum & Coal Products	0.7	.154
8. Clothing	0.6	.056
9. Furniture & Fixtures	0.3	.124
10. Metal Fabricating	1.6	.083
11. Machinery	0.8	.143
12. Transportation Equipment	1.0	.101
13. Electrical Products	0.4	.083
14. Chemical Products	1.0	.059
15. Residual Manufacturing	0.7	.074
Total Manufacturing	16.6	.051

Table 3-25

Manufacturing Industry Employment Weights and Instability Measures, 1970-1983, British Columbia

Industry	Employment Weight	Instability Measure
	(per cent)	
1. Food & Beverages	3.9	.106
2. Printing & Publishing	1.2	.077
3. Wood Products	9.5	.108
4. Paper & Allied Industries	4.4	.096
5. Primary Metals	1.8	.071
6. Non-Metallic Mineral Products	0.7	.065
7. Petroleum & Coal Products	0.2	.071
8. Clothing	0.5	.088
9. Furniture & Fixtures	0.3	.118
10. Metal Fabricating	1.7	.089
11. Machinery	0.8	.144
12. Transportation Equipment	1.5	.121
13. Electrical Products	0.7	.083
14. Chemical Products	0.6	.043
15. Residual Manufacturing	0.8	.063
Total Manufacturing	28.5	.063

Chapter 4: DIVERSIFICATION ANALYSIS OF WESTERN CANADA MANUFACTURING

In this chapter we develop and illustrate the concept of economic diversification originally mentioned in Chapter 1. The concept and development is mainly oriented to resolve some "puzzles" with respect to employment instability indicated in the previous Chapter 3. This chapter contains tables and computer graphics designed to serve as background for the optimal portfolio analysis of the next chapter. Some exercises are also included as a step in the direction of more advanced analysis. It should again be noted, as it was in Chapter 1, that the "diversification" concept is used here in a specific sense and that there are other aspects of diversification that are not embodied by our main analysis. Our diversification concept is similar to its meaning in financial analysis and closely-related areas, but considerable modification is required to make the concept "work" in an industrial analysis such as this study. The main discussion relating to the motivation behind diversification analysis and reduction of employment instability (subject to constraints) can be found in the next chapter. Once again it should be emphasized that the present chapter contains material over and above the consideration of Western Canada manufacturing. Finally, the material presented here tends to become technical in nature. We deliberately try to avoid purely technical discussion and relegate such matters to the Appendices.

What is Economic Diversification?

Perhaps the best way to introduce the topic of economic diversification is to first reconsider the notion of employment instability discussed in the previous chapter. There we found that it is possible (indeed, rather common) for employment instability of an aggregate (e.g., provincial economy as a whole) to be less than the employment instabilities of all the corresponding disaggregates (e.g., individual sectors of the provincial economy). More generally, it is evident that employment instability of an aggregate is not necessarily equal to an employment weighted average of the disaggregated employment instabilities. In fact, no other weighted average can do the "job" except in special cases. It is not difficult to realize that a statistical measure such as employment instability is, inherently, of a different nature compared to our other statistical measures such as the employment growth rate and average wage and salary level. Employment instability contains an essential temporal dimension that must be accounted for in the aggregation and disaggregation processes. It is not enough to know only the magnitudes of the disaggegated employment instability measures (referred to as own-industry or own-sectoral instability measures); we must also know the inherent temporal connections between each possible pair of disaggregated employment instabilities (referred to as cross-industry or cross-sectoral instability measures). Of course, the relative importance of each disaggregated entity, measured by employment weights, is also relevant, but this is not a new issue.[1]

Consider, then, the three simple diagrams that follow.[2] In Diagram 4-1, the economy is composed of two industries, industry A and industry B. Each industry is described by a smooth curve showing the industry's employment fluctuations around trend (assumed, for simplicity, to be constant) relative to the industry's average employment level over the time period concerned. We may assume, again for simplicity, that the two industries have equal employment levels (their employment weights equal 0.50). This assumption permits us to focus on the relative configuration of the two curves displaying employment fluctuations over time. In Diagram 4-1 it is clear that industry B's employment instability is greater than that of industry A since the absolute values of industry B's employment fluctuations around trend are always greater than those of industry A. In this diagram, moreover, there is a special relational configuration between the two curves; the peaks and troughs of the two smooth cyclical curves coincide respectively over time in a uniform manner. One might say that the temporal behaviour of the two industries with respect to employment is identical (or "reinforced"), except that one is an "exaggregated" version of the other. What, then, would be the employment instability measure of the aggregation of the two industries? In this very special case, indeed, the aggregate employment instability would be equal to an employment weighted average (in fact a simple average) of the employment instability measures for the two disaggregated industries. More generally, the "traditional" employment weighted average rule is preserved here because the employment fluctuations of the two (or more) industries are perfectly and positively correlated.[3]

Diagram 4-1, however, is only one possibility. Consider next Diagram 4-2. Once again, it is assumed (for convenience) that the two industries display smooth uniformly cyclical variations around a constant trend and the two industries are of equal importance in terms of employment weight. We even assume that the two industries exhibit equal degrees of employment instability. But now the temporal patterns of employment behaviour are radically different within the two industries; in fact the respective configurations are diametrically opposed. Industry A's peaks coincide with industry B's troughs while industry B's peaks coincide with industry A's troughs. One might say that the two patterns of employment fluctuations are countervailing. What would be the aggregate employment instability measure in this case? It is not difficult to intuit (and formally prove) that aggregate instability equals zero because the countervailing configurations of employment fluctuations results in a complete "cancellation" effect. Here the two (or more) industries are really different, not because one is called "A" and the other "B", but because their employment economic behaviour is different over time.

However, in order to be different it is not essential for industries' employment patterns to be completely countervailing. In Diagram 4-2 the employment fluctuations of the two industries are perfectly and negatively correlated. Let us, therefore, turn to an intermediate case, Diagram 4-3. The assumptions underlying this diagram are identical to those of Diagram 4-2 except that the respective industries' cyclical employment fluctuations are now partly "out-of-phase" with each other. Industry A's peaks and troughs coincide with industry B's trend, while industry B's peaks and troughs coincide with industry A's constant trend line. The temporal employment behaviour of the two industries differ, but are not diametrically opposed. In this, again, rather special case, the employment fluctuations around trend of the two industries are actually zero correlated. It is possible to show that aggregate employment instability is then equal to approximately 70 per cent of each industry's measure of employment instability;4 there is a partial "cancellation" effect.

Other intermediate cases can easily be added, but perhaps enough has been shown to introduce some diversification analysis. In this study we regard provincial employment in two or more classified industries as representing economic diversification only if each pair of industries' employment fluctuations around trend are at least partly countervailing. A word of warning, though, must be given. The described condition would be trivially satisfied on the basis of almost any official industrial classification, since it would rarely (if ever) happen that a particular observed pair of industries' employment variations around trend turn out to be perfectly and positively correlated! It is only in this extreme case of correlation equal to unity, that the countervailing phenomenon is completely absent and the existence of employment in the two industries offer no "cancellation" effect. In reality, therefore, it seems best to distinguish the possibility of successful economic diversification: the varied employment experiences over time of each pair[5] of classified industries results in significant reduction of employment instability at the total provincial level. Clearly this "definition" of successful economic diversification is not exact and is open to interpretation. The definition, however, does permit us to at least distinguish extreme cases and serves as an indication of when and under what circumtstances employment instability can be "optimally" reduced by changing the employment mix of a given industrial classification.[6]

We have tried to indicate that the aggegation "puzzles" relating to the measure of employment instability, mentioned in the last chapter, can be resolved by appealing to the concepts of economic diversification. In Diagram 4-1, there is no true economic diversification and so there is no aggregation "puzzle" -- the weighted average rule continues to hold. In Diagram 4-2, economic diversification is so powerful that aggregate employment instability is completely eliminated even though each of the disaggregated industries experience significant employment instability. In Diagram 4-3, there is successful (but not "all-powerful") economic diversification; aggregate employment instability is significantly less than that of each component industry. The three diagrams, nevertheless, depict highly idealized situations. What happens when there are many distinguished industries (or sectors) each of whose employment fluctuations around a non-linear trend (and relative to the respective industries' average employment levels over time) are highly irregular? Indeed, in the third section of this chapter, we show six cases of computer graphics illustrating industrial employment fluctuations around trend based on observed data for the period 1970-83. It should be clear that some mathematical formalism is needed in order to specifically account for the temporal relationships between the various configurations of employment fluctuations experienced by different industries.

It turns out that the required methodology is rather analogous to the formalism used to measure (the previous) own-industry employment instabilities. For each pair of industries we need to measure cross-industry employment instabilites and these terms are essentially based on the average of cross-product employment deviations rather than squared deviations.7 Cross-product employment deviations are reminiscent of statistical covariance expressions and must again be appropriately scaled to permit (inter-provincial) comparability. Finally it is possible to show that aggregate employment instability is then equal to a quadratic employment weighted summation of each industries' own-employment instability and all possible pairs of industries' cross-employment instabilities. This is not a theory!, it is a straight-forward industrial decomposition of measured aggregate employment instability extremely useful for industrial policy directed towards reducing aggregate provincial employment instability. The decomposition procedure is actually an identity[8] that holds for any level of industrial disaggregation.

Further clarification of these ideas can only be obtained by illustration. We, therefore, present a series of tables in the next section emphasizing the importance of cross-sectoral employment instability relations. The third section of the chapter deals with cross-industry instability relations within the Western Canada manufacturing sectors.

Cross-Sectoral Employment Instability Relations

We now know that provincial employment instability reflects not only the own-employment instabilites of provincial industries, but also the covariance relations between the employment instabilites of the different industries. At the same time, of course, the provincial-wide measure depends on the employment weights attached to the various industries; the weights, in quadratic form, are used in the overall summation mechanism. This permits us, with some approximation,[9] to estimate the relative importance of the two main types of employment instability effects. Table 4-1 shows the percentage contribution of own-sectoral instability and cross-sectoral instability to the measure of provincial employment instability based on the sectoral disaggregation used in

Tables 3-11 to 3-16 of the previous chapter. The measure of provincial employment instability, that is decomposed in the new Table 4-1, coincides with our chosen measures originally given in Table 3-2 (mid-column). It is clear from the results in Table 4-1 that the cross-sectoral instability component is by far the more important in all six Canadian provinces. This means, generally speaking, that employment pattern fluctuations (around long-term growth trends) tend to be positively and significantly correlated across different sectors in each of the six provinces. Note that some of the sectoral covariances may be negative or close to zero, but the positive covariances dominate the temporal relationships and outweigh the sectors' own-employment instability effects.

The results in Table 4-1 must be interpreted in the light of the employment coverage provided by the larger-firm survey (see again Chapter 2). What happens if agriculture employment is added to the coverage of the larger-firm survey? We already know that some of the provincial employment instability measures are dramatically altered by the inclusion of agriculture (see again Table 3-4 of the previous chapter). Table 4-2 shows the contribution of the two basic types of employment instability effects with agriculture (the implied measure of provincial employment instability comes from Table 3-4, first column). Once more there are some dramatic changes in relative importance, particularly for Saskatchewan, and to a lesser extent for Alberta. The results, though, are not entirely surprising in view of the provincial employment weights and instability measures displayed for the provincial agricultural sectors in Table 3-17 of the previous chapter. In order, however, to fully clarify the situation we must provide some sectoral detail concerning the covariance between sectoral employment fluctuations within each of the provinces. This, in fact, is done in the following series of six tables, Table 4-3 to Table 4-8.

Each table shows the triangular matrix of correlation coefficients underlying the (scaled) covariances of sectoral employment instabilities, 1970-83, within each province. It is more revealing to display the cross-sectoral relations in terms of correlation coefficients rather than as (scaled) covariances, the latter being the form that the relations actually take in the mathematical formalism basic to the decomposition identity.[10] Clearly all diagonal elements in each table equal unity. It is immediately apparent that almost all correlation coefficients are positive and many of the coefficients are quite large (greater than 0.50). On the other hand, all non-diagonal elements are less than unity and some of the coefficients are close to zero. These statements hold, generally speaking, within each province. Therefore sectoral employment fluctuations experienced in each province already permits economic diversification and, as we shall see later on, there is a reasonable degree of successful economic diversification in all provinces. Some provinces, however, are more successful than others in this respect and so further analysis is required.[11]

It is very tedious to comment on the whole range of individual correlation coefficients experienced by sectoral employment pairs in each province. Generally speaking, though, the result that positive and significant coefficients dominate the employment fluctuation relationships supports the "stylized facts" of medium-term business cycle analysis. The major sectoral employment variations (around trend) typically conform over the business cycle and, perhaps, shorter-term time periods. In the language of modern time series analysis, there is a large degree of sectoral employment coherence, even at the provincial level.[12] This theme will be discussed again in the next section and particularly Chapter 5 wihin a more analytical framework. For the present, it is possible to resolve some "puzzles" relating to the agricultural sector. By observing the first row of correlation coefficients in each table, it is evident that the agricultural sector employment in British Columbia tends to be zero correlated or even negatively correlated with some other major sectors' employment within that province. This particular experience does not occur in the other provinces. Therefore, British Columbia agriculture, though relatively small and also relatively own-unstable, is a good example of successful economic diversification. The addition of agriculture employment to the larger-firm survey results in a net decrease of provincial employment instability in contrast to the situation in all other provinces. One might say that agricultural employment is an indirect source of overall employment stability in British Columbia because the stability effect in this case works through the vector of agriculture's covariance elements. On the other hand, in Saskatchewan, agricultural employment is a direct source of provincial employment instability since the prime instability effect works thrugh agriculture's own employment variance element. This crucial distinction between direct and indirect effects will turn up time and again in later discussion.

Before continuing it might be noted that correlation matrices such as Tables 4-3 to 4-8 can be summarized by calculating a "typical" element (using the sectoral employment weights in quadratic summation form). The typical element does have convenient properties for more advanced theoretical work and some exercises along those lines have been performed. For industrial policy purposes, however, the full correlation matrix (and the more disaggregated matrix in the next section) is most valuable: the pattern and variety of displayed correlation coefficients between sectoral employment fluctuations within each province provides a precise route for obtaining reductions in provincial employment instability without sacrificing other desirable economic goals. This is the main theme of Chapter 5. But further background is still needed.

We have seen that all six Canadian provinces already benefit from some degree of economic diversification. In order to further characterize the situation, it is useful to consider a related question. What would happen if, for each province, economic diversification were impossible? In this hypothetical situation, all non-diagonal correlation coefficients are set equal to unity;

in effect all sectors within each province are supposed to have the same temporal behaviour pattern with respect to monthly employment fluctuations around sectoral long-term trends. It is important to note that own-sectoral employment instability measures can (and do) continue to differ even under the stated hypothetical condition (see again Diagram 4-1). We know that in this special case, the measure of provincial employment instability is equal to an employment weighted average of all sectoral employment instabilities. In fact the data for such a calculation comes directly and only from the respective tables 3-11 to 3-16 of the previous chapter. The results of the calculation, one for each province, are shown in the second column of a new Table 4-9. For convenience, the actual provincial employment instabilities are given in the first column of the table. Comparing the results in the two columns provides us with an indication of the exploited[13] existence of economic diversification in the six Canadian provinces. This idea is further pursued in the next chapter. It is revealing to note that the original (column one) ordering of provincial instability measures is preserved under the hypothetical condition: each of the Western provinces is more unstable (particularly Alberta) compared to each of the Central provinces (particularly Ontario). Also, Alberta does not appear to benefit much from the possibility of economic diversification; there is a proportionally small difference between the two indications of employment instability for that province.

It is also possible to calculate another hypothetical measure of provincial employment instability. Column three of Table 4-9 shows the case where all non-diagonal correlation coefficients between sectoral employment fluctuations are set equal to zero (reminiscent of Diagram 4-3). Now successful economic diversification is supposed to be uniformly available to all provinces. Again the original own-sectoral employment instabilities and employment weights, from Tables 3-11 to 3-16, are maintained, but the assumed countervailing aspects of the sectoral employment fluctuations result in a significant reduction of provincial-wide employment instability. The ordering of the provincial measures is once again preserved under the zero correlation hypothesis, though the estimates become more similar in magnitude. The real world situation of column one (without agriculture), then, is somewhere between the "most unfavourable" case represented by uniform perfect and positive correlation and "a significantly favourable" case14 represented by uniform zero correlation. All provinces are slanted towards the unfavourable case, but some are more slanted than others.

To close this section we briefly consider two more tabular results. These results provide useful background for the more systematic analysis of Chapter 5. The measure of provincial employment instability is identical whether calculated directly from provincial-wide employment fluctuations around trend or whether calculated indirectly on the basis of a quadratic employment weighted summation of all the vaiance-like and covariance- like elements of sectoral disaggregated employment fluctuations around trend (after appropriate scaling). This is the basic decomposition identity mentioned earlier. It is possible, however, to experiment with alternative sets of sectoral employment weights, though at the risk of "losing" the basic identity. The risk is worth paying if the alternative sets of weights are well-chosen and if, by simulation, we could approximate the "cost" of the risk.[15] Now the standard measures of provincial employment instability, used throughout the study, are implicitly based on (sectoral) employment weights taken over the full time period 1970-83. If (sectoral) employment weights were alternatively calculated, or taken, from some other (sub) period, then the measures of provincial employment instability would change. It seems natural in our context to experiment with two sets of sectoral employment weights; one taken from the (monthly) subperiod 1970-72 and the other based on the subperiod 1981-83. We should expect the relative changes in sectoral employment weights to reflect differential sectoral employment growth rates (see Tables 3-5 to 3-10) wihin each province. This expectation is correct and could easily be made more precise.[16] We then calculate two sets of provincial employment instabilities. Both sets are based on the same matrix of sectoral variance and covariance elements, appropriately scaled, measured from sectoral monthly employment fluctuations around trend for the full period 1970-83. The first set, though, uses 1970-72 sectoral employment weights; the second set uses 1981-83 sectoral employment weights. The results can be found in Table 4-10. The results serve as an indication of whether changes in observed sectoral employment weights over time (stemming from differential sectoral employment growth rates) have had a significant effect on provincial employment instability. It seems clear from Table 4-10 that the effect of such changes is minor. Most provincial measures show slight downwards movement (i.e., a favourable trend) as a result of shifts in sectoral employment weights during the time period. The one exception is the province of Alberta. Care, however, should be exercised in interpreting this result because the basic decomposition identity (invariance to disaggregation level) is not precisely satisfied. It is most revealing to note that the ordering relation of the six provincial measures is maintained throughout the experiment.

The results of Table 4-10 should not be understood to measure provincial employment instabilities over the two subperiods 1970-72 and 1981-83. If one is interested in knowing, for example, provincial employment instability for the time period 1981-83, then both the matrix of sectoral employment fluctuation variance and covariance elements and the sectoral employment weights must come from the same period, namely 1981-83. This has not been done; in fact, it cannot be done. Why? Because a two-year monthly time period, such as 1981-83, is much too short to reflect the medium-term (cyclical) and structural employment fluctuations around trend that we want our measure of provincial employment instability to embody. Therefore, all the basic elements providing indications of employment fluctuation around trend must come from a longer-term time period such as 1970-83.[17] Finally, Table 4-11 exhibits the results of another related experiment. In the second column of the table, all provinces are assigned the Ontario sectoral employment weights originally given in Table 3-12 (full period 1970-83). Recall that the manufacturing sector is particularly important in Ontario (employment weight equal to 42.9 per cent). The "result" helps to reduce Alberta's instability with respect to employment, but not the other Western provinces. Given this, rather crude and unrealistic experiment, suggests that reduction of provincial employment instability calls for some discrimination -- reflecting the particular behavioural patterns of disaggregated employment instability within each province.

Cross-Manufacturing Industry Instability Relations

So far in this chapter the manufacturing sector has been treated as an aggregate. Yet we know that manufacturing is a heterogenous sector[18] as evident from the tabular data presentation in the third section of the previous chapter. More important, the manufacturing sectors of Western Canada are the main focus of inquiry in this study. Therefore this section contains an industrial disaggregation of the manufacturing sectors from the viewpoint of diversification analysis (the main theme of the chapter). The particular disaggregation is identical to that described in the previous chapter. Once again we only show tabulations for the four provinces of Western Canada in order to save space. The reader, though, might be interested in obtaining corresponding tabulations for Quebec and Ontario from the authors of this study. Indeed, the full comparison of all six provinces reveals interesting patterns of similarity though each province has unique features.

First, it is possible to focus exclusively on the provincial manufacturing sectors and prepare tables analogous to Table 4-1 for each provincial sector. The respective tables would then indicate the contribution of own-industry instability and cross-industry instability to our measures of manufacturing sector employment instability within the four Western provinces. In these calculations the manufacturing industry employment weights, originally given in Tables 3-13 to 3-16, must be proportionally raised to sum to 100 per cent. Though such calculations may be of some interest, the effort would direct attention away from one of the principal lessons of this study,[19] namely the need to explicitly consider manufacturing in the context of the whole provincial economies. It is, nevertheless, true that the conceptual discussion and analysis of economic diversification, presented in this chapter, can be applied mutatis mutandis to each province's manufacturing sector. In this way some "puzzles" relating to aggregate manufacturing and disaggregated manufacturing employment instabilities (stated towards the end of the previous chapter) can be resolved. One can even run tables analogous to Tables 4-9, 4-10, and 4-11 with respect to each Western province's manufacturing sector.

In this section we do, however, show tables (matrices) of correlation coefficients underlying disaggregated manufacturing cross-industry employment instabilities. The rationale of the elementary coefficients is entirely analogous to those shown and explained for Tables 4-3 to 4-8. Consider then, the new set of Tables 4-12 to 4-15. Each table consists of a triangular matrix of correlation coefficients followed by a rectangular matrix of correlation coefficients. The triangular matrix displays, in correlation coefficient form, the cross-industry employment instability relations within the respective manufacturing sector, one for each Western province. The rectangular matrix shows the (transformed) employment instability relations between the disaggregated manufacturing industries, on the one hand, and the non-manufacturing sectors of the provincial economies on the other hand. Note that the full rectangular matrix of correlation coefficients must be calculated in the latter case. Each of the Tables 4-12 to 4-15 in conjunction with the corresponding provincial Tables 4-5 to 4-8 then embody a complete matrix description of correlation coefficients relevant to the concerns of this study. It is trivial to put together the provincially corresponding sets of tables (one from the first set, the other from the second set) by merely eliminating the manufacturing sector from Tables 4-5 to 4-8 and replacing it with the collection of manufacturing industries from Tables 4-12 to 4-15 respectively. One comment though must be added. We do not have correlation coefficients between individual manufacturing industries and the agricultural sector.20 Thus the agricultural sector in Tables 4-5 to 4-8 must also be eliminated in the conjunction (synthesis) operation.

The manufacturing sector in this study is industrially disaggregated not because "someone told us to do it." The disaggregation of manufacturing is essential in order to illustrate the power of discrimination in economic diversification analysis. Some idea of this phenonemon can easily be obtained by observing the wide range of industrial correlation coefficients within each province's manufacturing sector. This means, in effect, that the manufacturing sector employment own-instability measure need no longer be regarded as a "constant", but becomes a "variable" once the employment composition (mix) within manufacturing is permitted to change. Similarly the rectangular coefficient sub-matrices of Tables 4-12 to 4-15 illustrate the wide range of correlation between each non-agricultural business sector and the various manufacturing industries. The range of variation is entirely concealed when manufacturing is considered as a whole (as in Tables 4-5 to 4-8). Economic diversification analysis, as performed in the next chapter, thrives on the potency of industrial discrimination. In fact, it will be argued in the concluding chapter of the study, that our disaggregated analysis does not "go far enough". We also add that the manufacturing disaggregation performed in the study is directly useful to provide material for certain industry policy issues such as the question of "further processing". Some light is thrown on this and related issues by carefully observing the magnitudes of certain correlation coefficients later in the study.

To conclude this chapter, we feel it would benefit the reader to observe some employment fluctuations around trend actually experienced by specific sectors and manufacturing industries. The following charts can then be "connected up" with the relevant correlation coefficients in previous tables. We show six individual charts, namely Charts 4-1 to 4-6. (Many more such charts have been computerized by the authors and are available on request.) Each chart has the following format. The horizontal axis measures time, running from 1 to 78 since there are 78 monthly (actually semi-monthly)[21] observations covering the time period April 1970 to March 1983. The vertical axis measures scaled employment; whenever actual or trend employment equals mean employment over the time period, the value on the chart is 100. This latter operation is strictly for convenience of presentation and has no substantive effect on the illustrations (essential correlation properties of employment fluctuations around trend are preserved).[22] Thus each chart shows employment observations (transformed) and, implicitly, the deviations of employment from the non-linear quadratic trend curve of employment over time. Consider first Chart 4-1, the forestry sector of British Columbia. The long-run trend curve is slightly down over the period (the long-term employment growth rate equals -0.5 per cent from Table 3-10). Employment fluctuations around trend are quite large (the employment instability measure equals 0.137 from

Table 3-16). Consider next Chart 4-2, the wood products manufaturing industry of British Columbia. The long-run trend again moves up and down ending up at no change (employment growth rate equals -0.1 per cent from Table 3-21). Employment fluctuations around the moving trend are also large (employment instability measures 0.108 from Table 3-25). This, however, is not all! The two charts are related by the correlation coefficient in the woood products "row" and the forestry sector "column" of Table 4-15, namely 0.76. The magnitude of the coefficient is higher than that of any other sector or industry related to wood products and also higher than that of any other sector or industry related to forestry in British Columbia (see also Table 4-8). The magnitude of correlation is intuitively evident from "matching" the co-movements around trend in the two charts and, more important, the correlation magnitude is plausible on economic grounds (see further discussion later in study).

The next set of charts, Charts 4-3 and 4-4, cover the petroleum and coal products manufacturing industry and the electrical products manufacturing industry of Alberta. The relevant data from Chapter 3 shows:

	employment growth rate	instability measure
Chart 4-3	10.6 per cent	0.154
Chart 4-4	3.5 per cent	0.083

and the correlation coefficient between respective employment fluctuations around trend equals -0.36 (Table 4-14). There is, then, a sharp distinction between the two sets of Charts so far indicated. A more intermediate case involves Charts 4-5 and 4-6 covering the clothing manufacturing industry and construction sector of Manitoba. The relevant data from Chapter 3 are:

	employment growth rate	instability measure
Chart 4-5	-0.8 per cent	0.053
Chart 4-6	-5.1 per cent	0.134

and the correlation coefficient between respective employment fluctuations around long-term moving trend equals -0.07 (Table 4-12).

To summarize, then, the first two charts display a case where a natural resource sector (forestry) and a primary manufacturing industry (wood products) experience highly correlated employment fluctuations around their respective trends in the particular province (British Columbia). The two employment experiences together offer little economic diversification. There is no significant reduction in provincial employment instability when the employment "mix" between the forestry sector and the wood products manufacturing industry changes. In fact it may not be possible to change the mix because the two respective sources of employment are so tied together. The next set of charts, Charts 4-3 and 4-4, display the existence of successful economic diversification and the opportunity to further reduce Alberta's employment instability. The two Alberta manufacturing industries have significantly negative correlated employment fluctuations around trend, but the employment distribution between the two industries may or may not be "optimal". If employment distribution is not "optimal",23 then there are potential gains to be made from further exploiting the existence of economic diversification. The final set of charts, then, show the intermediate situation where employment in the Manitoba clothing manufacturing industry offers a good opportunity to economically diversify "against" the seasonal employment fluctuations around trend that dominate Manitoba's construction sector.

Notes

1 For the present we may pretend that all disaggregated entities have equal employment weights; see later discussion in this section and the full technical account in Appendix A.

2 Thanks are due to Thomas Schweitzer for suggesting the use of such diagrams.

3 Technical statements in this section are futher developed, with reference to the technical literature, in Appendix A.

4 At least based on the special assumptions underlying Diagram 4-3.

5 If the presently stated condition is satisfied by some, but not all, possible pairs of classified industries, then we may refer to partially successfull economic diversification.

6 This theme is discussed at great length in the next chapter.

7 Recall the measure of provincial employment instability described in Chapter 3 (first section). The full technical account can be found in Appendix A.

8 When the decomposition procedure is modified, in some exercises to follow, the identity no longer holds and the results do depend on the industrial disaggregation level.

9 The results in Tables 4-1 and 4-2 are subject to some arbitrary (but not misleading) assumptions; see Appendix A.

10 The precise relationship between the matrix of correlation coefficients and the underlying matrix of (scaled) covariances is given in Appendix A.

11 This will become apparent in Chapters 5 and 6.

12 A good recent account of business cycle analysis is R.E. Lucas (1977).

13 The question of whether or not economic diversification is "fully" exploited (subject to reasonable constraints) is implicity considered later in the study.

14 The "most favourable" case would involve uniform perfect and negative correlations resulting in hypothetical employment instabilities, for each province, close to zero (see Appendix A).

15 This has been done to some limited extent.

16 The topic occurs again in Chapter 6 of the study.

17 These considerations are renewed in the analysis of the next chapter.

18 Actually all sectors are heterogeneous and there are definite benefits from disaggregating all sectors even though manufacturing is our main focus; see suggestions for future research in Chapter 6.

19 This will become more evident in the next chapter.

20 These coefficients could easily be calculated, but the prime concern of the study rests within the non-agricultural business sectors of the Western provinces based on the larger-firm survey. The agricultural time series data is not consistent with our survey, but does serve to illustrate some key points.

21 Recall the use of two-month averages as our basic unit observation (first section of Chapter 3).

22 See Appendix B for further details concerning construction of charts by computer graphics. Note that the charts do correctly indicate our measures of employment instability since our scaling factor is essentially the same as that used for convenience of chart construction.

23 Here we are anticipating developments spelled out at great length in the next chapter.

Diagram 4-1

Hypothetical Employment Fluctuations Around Trend, Two Industries, Case of Perfect Positive Correlation

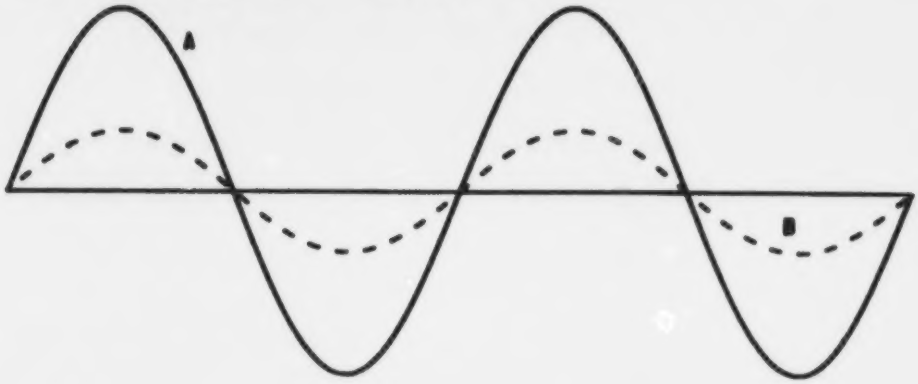


Diagram 4-2

Hypothetical Employment Fluctuations Around Trend, Two Industries, Case of Perfect Negative Correlation

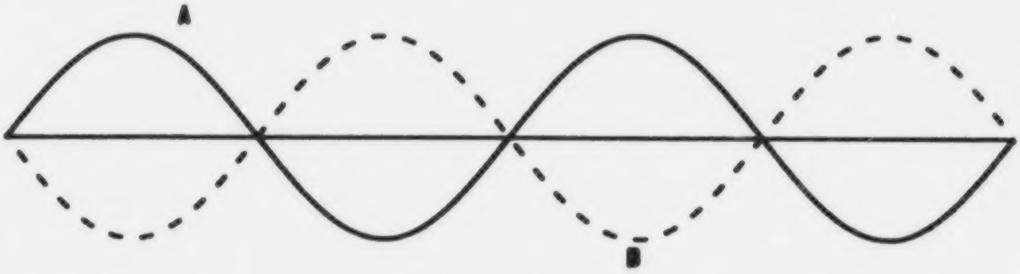


Diagram 4-3

Hypothetical Employment Fluctuations Around Trend, Two Industries, Case of Zero Correlation

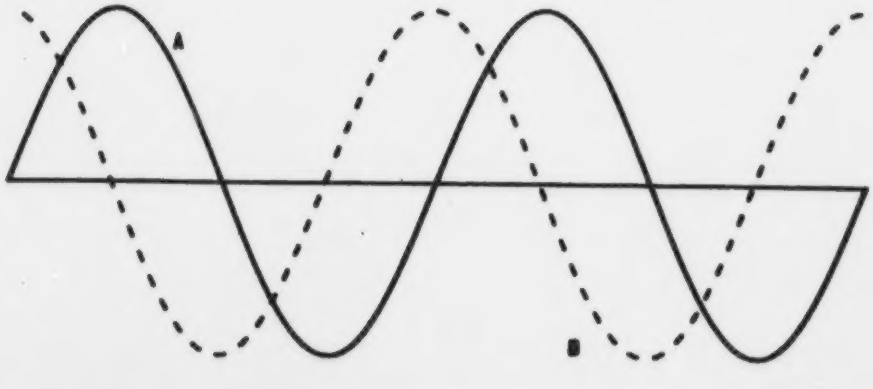


Table 4-1

Contribution of Own-Sectoral Instability and Cross-Sectoral Instability to Measure of Provincial Employment Instability, 1970-1983, Six Provinces

Province	Own-Sectoral	Cross-Sectoral
	(per cent)	(per cent)
Quebec	30.8	69.2
Ontario	37.0	63.0
Manitoba	33.7	66.3
Saskatchewan	27.3	72.7
Alberta	20.6	79.4
British Columbia	34.2	65.8

Table 4-2

Contribution of Own-Sectoral Instability and Cross-Sectoral Instability to Measure of Provincial Employment Instability with Agriculture, 1970-1983, Six Provinces

Province	Own-Sectoral	Cross-Sectoral
	(per cent)	(per cent)
Quebec	29.5	70.5
Ontario	31.3	68.7
Manitoba	40.0	60.0
Saskatchewan	73.6	26.4
Alberta	45.4	54.6
British Columbia	35.9	64.1

Table 4-3

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, Quebec

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.42	0.38	0.27	0.35	0.54	-0.09	0.24	0.46
FORESTRY		1.00	0.46	0.58	0.68	0.62	0.24	0.27	0.47
MINING			1.00	0.67	0.27	0.63	0.51	0.25	0.69
MANUFACTURING				1.00	0.47	0.62	0.67	0.30	0.75
CONSTRUCTION					1.00	0.39	0.02	0.00	0.40
TRNSP, COMM, UT						1.00	0.45	0.46	0.65
TRADE							1.00	0.45	0.53
FIRE								1.00	0.45
SERVICES									1.00

Table 4-4

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, Ontario

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.63	0.27	0.50	0.56	0.65	0.05	0.62	0.74
FORESTRY		1.00	0.07	0.65	0.22	0.59	0.30	0.62	0.74
MINING			1.00	0.23	0.39	0.39	0.16	0.43	0.34
MANUFACTURING				1.00	0.28	0.52	0.56	0.59	0.81
CONSTRUCTION					1.00	0.50	0.02	0.41	0.53
TRNSP, COMM, UT						1.00	0.25	0.69	0.73
TRADE							1.00	0.42	0.42
FIRE								1.00	0.77
SERVICES									1.00

Table 4-5

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, Manitoba

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.10	0.27	0.23	0.45	0.64	-0.20	0.60	0.57
FORESTRY		1.00	0.42	0.58	0.35	0.31	0.30	-0.25	0.55
MINING			1.00	0.58	0.42	0.49	0.47	0.04	0.56
MANUFACTURING				1.00	0.43	0.44	0.57	0.11	0.67
CONSTRUCTION					1.00	0.56	0.18	0.07	0.75
TRNSP, COMM, UT						1.00	0.05	0.54	0.66
TRADE							1.00	-0.17	0.27
FIRE								1.00	0.31
SERVICES									1.00

Table 4-6

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, Saskatchewan

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.49	-0.09	0.33	0.52	0.45	-0.18	0.11	0.43
FORESTRY		1.00	0.17	0.23	0.33	0.30	0.06	0.14	0.43
MINING			1.00	0.49	0.48	0.31	0.67	0.59	0.74
MANUFACTURING				1.00	0.44	0.76	0.37	-0.03	0.60
CONSTRUCTION					1.00	0.50	0.38	0.59	0.71
TRNSP, COMM, UT						1.00	0.37	0.01	0.55
TRADE							1.00	0.34	0.56
FIRE								1.00	0.57
SERVICES									1.00

Table 4-7

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, Alberta

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.49	-0.13	0.27	0.39	0.49	0.05	-0.08	0.16
FORESTRY		1.00	0.10	0.21	0.12	0.41	0.08	0.04	0.18
MINING			1.00	0.76	0.44	0.50	0.75	0.78	0.70
MANUFACTURING				1.00	0.74	0.76	0.80	0.83	0.86
CONSTRUCTION					1.00	0.76	0.54	0.68	0.78
TRNSP, COMM, UT						1.00	0.60	0.66	0.78
TRADE							1.00	0.83	0.72
FIRE								1.00	0.90
SERVICES									1.00

Table 4-8

Matrix of Correlation Coefficients Underlying Cross-Sectoral Employment Instabilities, 1970-1983, British Columbia

	AGRIC	FOREST	MINING	MANUF	CONSTR	TRNSP	TRADE	FIRE	SERVICE
AGRIC	1.00	0.08	-0.12	0.07	0.01	0.14	-0.32	0.29	0.23
FORESTRY		1.00	0.09	0.74	0.23	0.07	0.20	0.26	0.34
MINING			1.00	0.41	0.57	0.46	0.60	0.06	0.62
MANUFACTURING				1.00	0.25	0.22	0.52	0.36	0.56
CONSTRUCTION					1.00	0.56	0.42	-0.06	0.70
TRNSP, COMM, UT						1.00	0.29	-0.05	0.69
TRADE							1.00	0.09	0.55
FIRE								1.00	0.26
SERVICES									1.00

Table 4-9

Actual and Hypothetical Measures of Provincial Employment Instability, Perfect Correlation Case and Zero Correlation Case, 1970-1983, Six Provinces

Province	Actual	Perfect Correlation	Zero Correlation
Quebec	.0328	.0423	.0182
Ontario	.0287	.0371	.0175
Manitoba	.0337	.0481	.0196
Saskatchewan	.0409	.0552	.0214
Alberta	.0541	.0632	.0246
British Columbia	.0416	.0581	.0243

Table 4-10

Measures of Provincial Employment Instability Based on 1970-72 Employment Weights and 1981-83 Employment Weights, 1970-1983, Six Provinces

Province	1970-72 Weight	1981-83 Weight
Quebec	.0335	.0319
Ontario	.0292	.0285
Manitoba	.0341	.0326
Saskatchewan	.0419	.0394
Alberta	.0540	.0547
British Columbia	.0426	.0403

Table 4-11

Measures of Provincial Employment Instability Based on Own-Provincial Employment Weights and Ontario Employment Weights, 1970-1983, Six Provinces

Province	Own-Weight	Ontario Weight
Quebec	.0328	.0314
Ontario	.0287	.0287
Manitoba	.0337	.0336
Saskatchewan	.0409	.0404
Alberta	.0541	.0497
British Columbia	.0416	.0435

Table 4-12

Matrix of Correlation Coefficients Underlying Cross-Industry Employment Instabilities, 1970-1983, Manitoba Manufacturing Sector

OBS	INDUSTRY	FOOD	PRINTING	WOOD	PAPER	PRIM_MET	NONMETAL	CLOTHING	FURNTURE	MET_FAB	MACHINRY	TRNSP_EQ
1	FOOD & BEVERAGES	1.00	0.11	0.42	0.26	0.07	0.36	-0.23	0.12	0.06	-0.03	-0.17
2	PRINTING & PUBLISHING		1.00	0.19	0.15	-0.04	0.42	0.10	-0.34	0.51	0.10	0.40
3	WOOD PRODUCTS			1.00	0.40	0.23	0.43	0.20	0.32	0.44	0.27	0.16
4	PAPER & ALLIED				1.00	0.24	0.16	0.35	0.38	0.25	0.21	0.43
5	PRIMARY METAL					1.00	0.01	0.30	0.60	0.40	0.63	0.48
6	NON-METALLIC MINERAL						1.00	-0.06	-0.20	0.31	-0.18	-0.11
7	CLOTHING							1.00	0.39	0.17	0.11	0.61
8	FURNITURE & FIXTURES								1.00	0.21	0.47	0.41
9	METAL FABRICATING									1.00	0.43	0.56
10	MACHINERY										1.00	0.58
11	TRANSPORTATION EQUIP											1.00
12	ELECTRICAL PRODUCTS											
13	CHEMICALS & PR											
14	RESIDUAL MANUF											

OBS	INDUSTRY	ELECTRCL	CHEMICAL	RESIDUAL	FOREST	MINING	CONSTR	TRNSP	TRADE	FIRE	SERVICES
1	FOOD & BEVERAGES	0.16	0.03	0.16	0.20	0.32	0.67	0.39	0.04	-0.03	0.42
2	PRINTING & PUBLISHING	-0.21	-0.07	0.36	0.07	0.12	0.22	0.52	-0.09	0.68	0.44
3	WOOD PRODUCTS	0.28	0.23	0.32	0.48	0.40	0.67	0.51	0.19	0.13	0.66
4	PAPER & ALLIED	0.03	-0.24	0.39	0.40	0.10	0.28	0.35	0.18	0.03	0.34
5	PRIMARY METAL	0.18	0.21	0.50	0.47	0.61	0.11	0.14	0.57	-0.23	0.30
6	NON-METALLIC MINERAL	0.08	-0.09	0.22	0.10	0.29	0.46	0.66	-0.20	0.59	0.47
7	CLOTHING	-0.14	-0.27	0.32	0.28	-0.08	-0.07	0.06	0.09	-0.03	0.17
8	FURNITURE & FIXTURES	0.11	0.18	0.38	0.47	0.38	0.22	0.01	0.67	-0.42	0.26
9	METAL FABRICATING	-0.21	0.29	0.68	0.26	0.56	0.41	0.51	0.42	0.44	0.61
10	MACHINERY	0.28	0.50	0.43	0.42	0.44	0.14	-0.03	0.68	-0.21	0.29
11	TRANSPORTATION EQUIP	-0.26	-0.06	0.66	0.43	0.30	0.01	0.27	0.40	0.16	0.39
12	ELECTRICAL PRODUCTS	1.00	0.22	-0.24	0.30	-0.05	0.18	-0.15	0.11	-0.34	0.09
13	CHEMICALS & PR		1.00	0.16	0.08	0.39	0.33	-0.12	0.36	-0.15	0.33
14	RESIDUAL MANUF			1.00	0.24	0.59	0.23	0.42	0.32	0.25	0.45

Table 4-13

Matrix of Correlation Coefficients Underlying Cross-Industry Employment Instabilities, 1970-1983, Saskatchewan Manufacturing Sector

	INDUSTRY	FOOD	PRINTING	WOOD	PAPER	PRIM_MET	PETR_COA	CLOTHING	MET_FAB	MACHINRY	TRMSP_EQ
1	FOOD & BEVERAGES	1.00	0.10	0.21	0.20	0.28	0.34	0.33	0.33	0.17	0.11
2	PRINTING & PUBLISHING		1.00	0.06	-0.10	-0.13	0.26	0.07	-0.09	0.01	0.21
3	WOOD PRODUCTS			1.00	0.01	-0.10	0.01	-0.10	0.18	-0.13	-0.04
4	PAPER & ALLIED				1.00	0.18	-0.03	0.19	0.27	0.11	-0.14
5	PRIMARY METAL					1.00	0.17	0.13	0.22	0.18	0.07
6	PETROLEUM & COAL PR						1.00	0.29	-0.01	0.37	0.56
7	CLOTHING							1.00	0.31	0.50	0.44
8	METAL FABRICATING								1.00	0.10	-0.06
9	MACHINERY									1.00	0.64
10	TRANSPORTATION EQUIP										1.00
11	ELECTRICAL PRODUCTS										
12	CHEMICALS & PR										
13	RESIDUAL MANUF										

	INDUSTRY	ELECTRCL	CHEMICAL	RESIDUAL	FOREST	MINING	CONSTR	TRNSP	TRADE	FIRE	SERVICES
1	FOOD & BEVERAGES	-0.09	0.28	0.59	0.24	0.20	0.59	0.75	0.07	0.04	0.51
2	PRINTING & PUBLISHING	0.11	-0.07	0.14	-0.03	-0.13	-0.05	0.21	-0.10	-0.17	0.01
3	WOOD PRODUCTS	-0.13	0.17	0.13	0.24	0.22	0.56	0.21	0.20	0.43	0.34
4	PAPER & ALLIED	-0.18	0.24	0.06	0.04	0.31	0.14	0.00	-0.01	0.19	0.21
5	PRIMARY METAL	0.00	-0.02	0.46	0.02	0.34	0.04	0.31	0.17	0.02	0.14
6	PETROLEUM & COAL PR	-0.19	-0.02	0.49	0.28	0.29	0.16	0.47	0.31	-0.04	0.54
7	CLOTHING	-0.31	0.18	0.57	-0.18	0.27	0.02	0.38	0.35	-0.27	0.24
8	METAL FABRICATING	-0.45	0.05	0.43	0.01	0.67	0.50	0.25	0.34	0.41	0.46
9	MACHINERY	-0.43	0.16	0.52	0.23	0.37	-0.02	0.27	0.42	-0.26	0.39
10	TRANSPORTATION EQUIP	-0.32	-0.03	0.54	0.23	0.15	-0.11	0.46	0.35	-0.44	0.22
11	ELECTRICAL PRODUCTS	1.00	-0.08	-0.35	-0.08	-0.58	-0.30	-0.21	-0.52	-0.22	-0.51
12	CHEMICALS & PR		1.00	0.08	-0.17	0.04	0.18	0.05	-0.02	0.03	0.15
13	RESIDUAL MANUF			1.00	0.10	0.50	0.36	0.75	0.50	-0.07	0.55

Table 4-14

Matrix of Correlation Coefficients Underlying Cross-Industry Employment Instabilities, 1970-1983, Alberta Manufacturing Sector

	INDUSTRY	FOOD	PRINTING	WOOD	PAPER	PRIM_MET	NONMETAL	PETR_COA	CLOTHING	FURNTURE	MET_FAB	MACHINRY
1	FOOD & BEVERAGES	1.00	0.23	-0.22	0.41	0.27	0.63	0.59	0.31	0.35	0.55	0.29
2	PRINTING & PUBLISHING		1.00	0.04	0.21	0.82	0.57	0.55	0.54	0.79	0.66	0.86
3	WOOD PRODUCTS			1.00	0.00	-0.09	0.10	-0.08	-0.11	0.15	0.05	-0.17
4	PAPER & ALLIED				1.00	0.28	0.29	0.17	0.26	0.18	0.45	0.29
5	PRIMARY METAL					1.00	0.56	0.39	0.63	0.68	0.68	0.85
6	NON-METALLIC MINERAL						1.00	0.62	0.52	0.60	0.82	0.51
7	PETROLEUM & COAL PR							1.00	0.40	0.56	0.68	0.47
8	CLOTHING								1.00	0.46	0.68	0.68
9	FURNITURE & FIXTURES									1.00	0.72	0.75
10	METAL FABRICATING										1.00	0.65
11	MACHINERY											1.00
12	TRANSPORTATION EQUIP											
13	ELECTRICAL PRODUCTS											
14	CHEMICALS & PR											
15	RESIDUAL MANUF											

	INDUSTRY	TRNSP_EQ	ELECTRCL	CHEMICAL	RESIDUAL	FOREST	MINING	CONSTR	TRNSP	TRADE	FIRE	SERVICES
1	FOOD & BEVERAGES	0.08	0.04	0.58	0.07	0.07	0.36	0.81	0.62	0.37	0.61	0.70
2	PRINTING & PUBLISHING	0.64	-0.11	0.63	0.18	0.16	0.74	0.35	0.54	0.81	0.72	0.64
3	WOOD PRODUCTS	0.34	-0.17	-0.23	-0.12	0.46	0.06	-0.19	-0.14	-0.16	-0.20	-0.09
4	PAPER & ALLIED	0.30	-0.06	0.33	0.29	-0.24	0.26	0.39	0.25	0.19	0.28	0.33
5	PRIMARY METAL	0.62	-0.10	0.67	0.38	0.19	0.63	0.42	0.65	0.75	0.61	0.59
6	NON-METALLIC MINERAL	0.52	-0.15	0.72	0.01	0.39	0.60	0.72	0.76	0.63	0.71	0.82
7	PETROLEUM & COAL PR	0.23	-0.36	0.71	-0.32	0.03	0.72	0.54	0.44	0.63	0.82	0.70
8	CLOTHING	0.53	-0.03	0.78	0.45	0.08	0.51	0.51	0.53	0.59	0.62	0.60
9	FURNITURE & FIXTURES	0.61	-0.18	0.58	0.14	0.15	0.70	0.50	0.52	0.76	0.67	0.64
10	METAL FABRICATING	0.56	-0.29	0.82	0.07	0.15	0.76	0.70	0.65	0.80	0.80	0.83
11	MACHINERY	0.53	0.00	0.66	0.32	0.01	0.73	0.43	0.58	0.83	0.71	0.61
12	TRANSPORTATION EQUIP	1.00	-0.14	0.43	0.23	0.21	0.46	0.29	0.37	0.49	0.35	0.36
13	ELECTRICAL PRODUCTS		1.00	-0.22	0.28	-0.11	-0.24	0.04	0.05	-0.12	-0.22	-0.08
14	CHEMICALS & PR			1.00	0.19	0.02	0.68	0.69	0.68	0.74	0.91	0.85
15	RESIDUAL MANUF				1.00	0.03	-0.13	0.20	0.33	0.08	0.00	0.05

Table 4-15

Matrix of Correlation Coefficients Underlying Cross-Industry Employment Instabilities, 1970-1983, British Columbia Manufacturing Sector

	INDUSTRY	FOOD	PRINTING	WOOD	PAPER	PRIM_MET	NONMETAL	PETR_COA	CLOTHING	FURNTURE	MET_FAB	MACHINRY
1	FOOD & BEVERAGES	1.00	0.12	0.10	0.00	0.03	0.46	0.56	0.16	0.37	0.23	0.22
2	PRINTING & PUBLISHING		1.00	-0.18	0.04	0.13	0.19	0.01	0.28	0.05	0.19	0.12
3	WOOD PRODUCTS			1.00	0.47	0.35	0.34	0.31	0.20	0.40	0.43	0.43
4	PAPER & ALLIED				1.00	0.24	0.17	0.20	0.14	0.12	0.30	0.32
5	PRIMARY METAL					1.00	0.19	0.52	0.58	0.30	0.51	0.59
6	NON-METALLIC MINERAL						1.00	0.50	0.37	0.61	0.62	0.62
7	PETROLEUM & COAL PR							1.00	0.49	0.37	0.52	0.54
8	CLOTHING								1.00	0.56	0.68	0.67
9	FURNITURE & FIXTURES									1.00	0.81	0.74
10	METAL FABRICATING										1.00	0.84
11	MACHINERY											1.00
12	TRANSPORTATION EQUIP											
13	ELECTRICAL PRODUCTS											
14	CHEMICALS & PR											
15	RESIDUAL MANUF											

	INDUSTRY	TRNSP_EQ	ELECTRCL	CHEMICAL	RESIDUAL	FOREST	MINING	CONSTR	TRNSP	TRADE	FIRE	SERVICES
1	FOOD & BEVERAGES	0.24	-0.15	0.10	0.22	0.31	0.27	0.44	0.51	0.00	0.13	0.44
2	PRINTING & PUBLISHING	-0.10	0.28	0.22	0.16	0.00	0.30	0.44	0.33	0.23	-0.13	0.27
3	WOOD PRODUCTS	0.34	-0.58	-0.09	0.18	0.76	0.13	-0.07	-0.15	0.30	0.36	0.19
4	PAPER & ALLIED	0.15	-0.22	-0.01	0.20	0.54	0.05	-0.05	0.03	0.26	0.28	0.10
5	PRIMARY METAL	0.33	-0.23	0.32	0.36	0.24	0.53	0.23	0.18	0.52	0.23	0.46
6	NON-METALLIC MINERAL	0.51	-0.26	-0.12	0.54	0.40	0.45	0.48	0.37	0.47	0.20	0.63
7	PETROLEUM & COAL PR	0.30	-0.30	0.24	0.22	0.48	0.27	0.42	0.41	0.30	0.36	0.74
8	CLOTHING	0.47	0.05	0.12	0.55	0.18	0.59	0.57	0.33	0.68	0.02	0.65
9	FURNITURE & FIXTURES	0.63	-0.16	-0.07	0.68	0.29	0.53	0.44	0.35	0.75	0.07	0.62
10	METAL FABRICATING	0.68	-0.01	0.11	0.69	0.39	0.63	0.58	0.49	0.80	0.12	0.70
11	MACHINERY	0.71	-0.22	0.11	0.67	0.26	0.65	0.42	0.33	0.78	0.35	0.70
12	TRANSPORTATION EQUIP	1.00	-0.11	0.11	0.64	0.16	0.53	0.25	0.30	0.52	0.13	0.55
13	ELECTRICAL PRODUCTS		1.00	0.11	0.16	-0.38	0.06	0.34	0.39	0.03	-0.47	-0.01
14	CHEMICALS & PR			1.00	-0.21	-0.03	0.16	0.11	0.29	-0.01	0.39	0.31
15	RESIDUAL MANUF				1.00	0.05	0.67	0.48	0.43	0.66	-0.23	0.49

Chart 4-1

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Forestry Sector, British Columbia

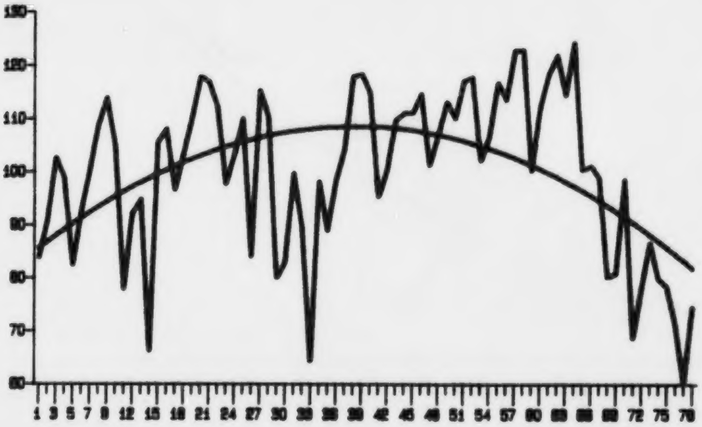


Chart 4-2

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Wood Products Manufacturing Industry, British Columbia

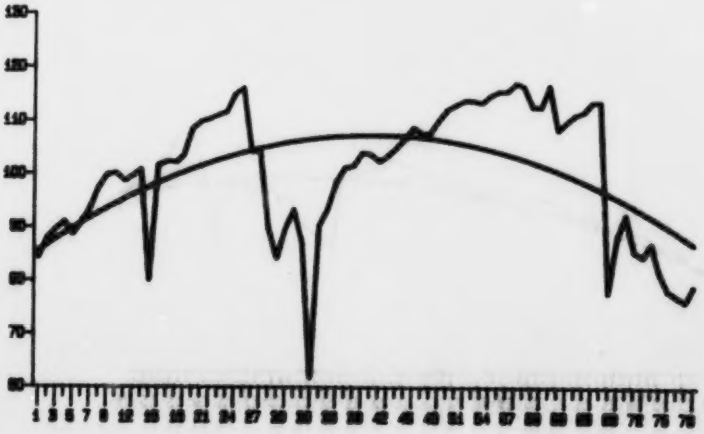


Chart 4-3

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Petroleum and Coal Products Manufacturing Industry, Alberta

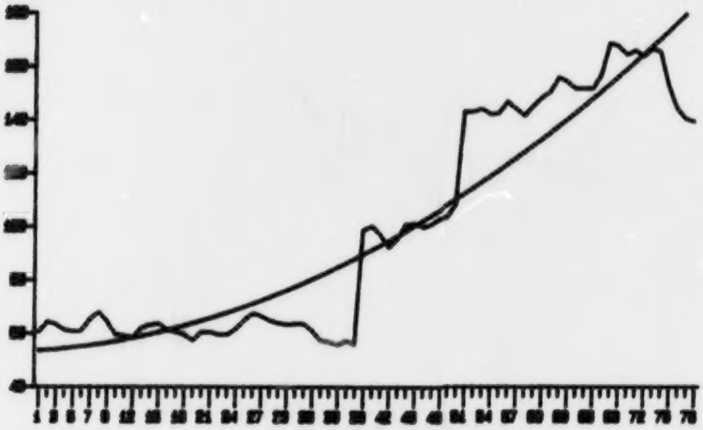


Chart 4-4

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Electrical Products Manufacturing Industry, Alberta

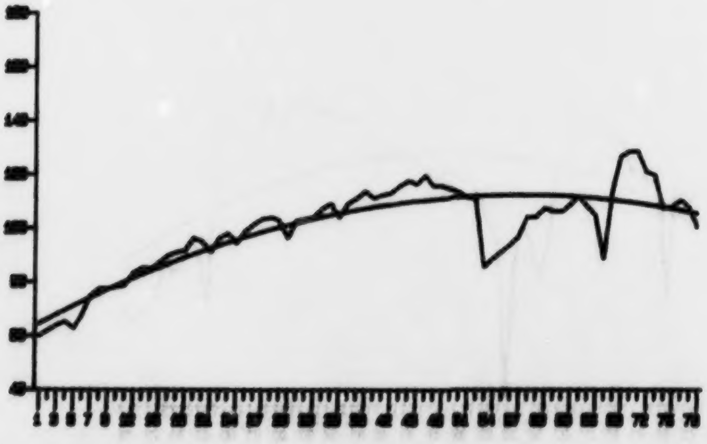


Chart 4-5

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Clothing Manufacturing Industry, Manitoba

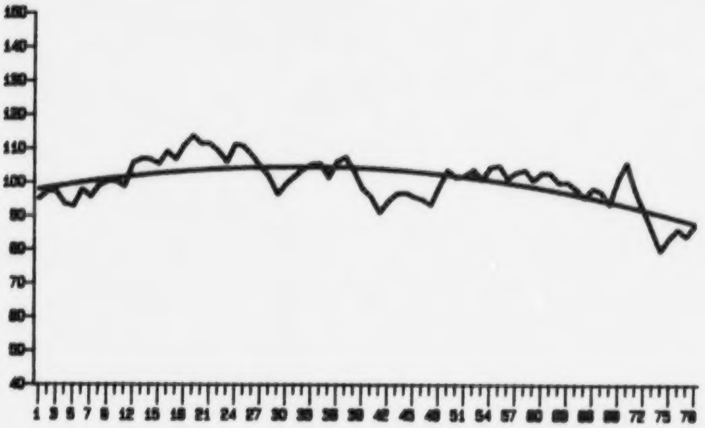
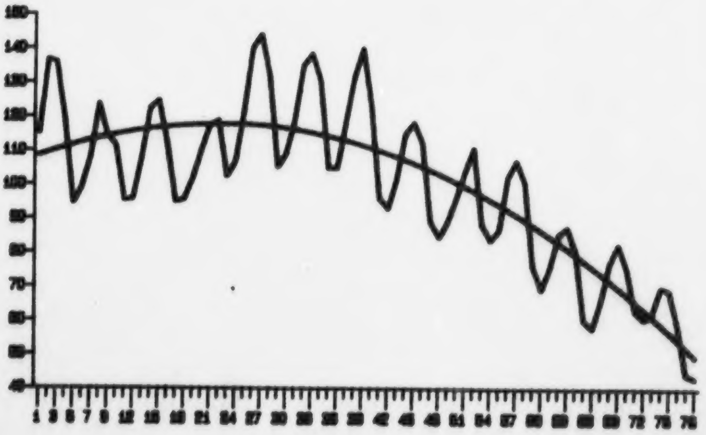


Chart 4-6

Employment Fluctuations Around Non-linear Trend, Scaled, April 1970 to March 1983, Construction Sector, Manitoba



Chapter 5: OPTIMAL PORTFOLIO ANALYSIS OF WESTERN CANADA MANUFACTURING

This is a key chapter of the study. Here the descriptive background of Chapter 3 and the introduction to diversification of Chapter 4 are brought together in an analytical framework. The emphasis is no longer on providing data or running some exercises; we are now interested in analytical results that have potential policy implications. Some of the themes of this chapter were mentioned in Chapter 1, but only in an introductory way. The basic analytical results are given in the second and third sections of this chapter. They are preceded by a rather lengthy section spelling out the motivation and rationale of optimal portfolio analysis in a provincial industrial context such as the one of this study. It should be noted that the analysis here is restricted to only the four Western Canada provinces; we have not performed optimization exercises for Quebec and Ontario. Once again, the discussion in this chapter tends to become technical because the analysis is based on a computerized quadratic (constrained) programming algorithm. The general idea of the analysis, nevertheless, can still be explained and understood without appealing to mathematical formalisms. Readers interested in technical details are referred to Appendix A and to specific programming literature. The chapter shows only some of the many cases (called scenarios) that have been run on our computer program; these cases are the ones that we feel are most instructive for possible future work. Finally, the chapter leads naturally to a number of industrial policy implications. But the full discussion of industrial diversification policy for Western Canada is reserved for Chapter 6 where the context is broader and less technical.

Background to Optimal Diversification Analysis

Let us begin by recapitulating the story revealed by Chapter 3. That chapter provides an aggregate and disaggregated picture of employment and labour income experience during the 1970-83 period in each of the four Western provinces. (Labour income can be obtained by merely combining employment levels with corresponding average wage and salary levels.[1]) The data base yields four statistical measures: (1) average employment level (aggregate) or employment weights (disaggregate) during the time period, (2) long-term employment growth rates over the period, (3) average weekly wage and salary levels during the 1970-83 period (called average "earnings" in this chapter), and (4) measures of employment instability based on monthly employment fluctuations around long-term employment trends. All these measures are developed for both the provincial economy as a whole and for sectoral and manufacturing industry disaggregations. It is reasonably clear, however, that the discussion in Chapter 3 is deficient in an important respect (even within the limited framework of that chapter). The various statistical measures are described rather separately; possible empirical relations between the statistical measures are not investigated and, indeed, the discussion in that chapter has no real analytical direction. Consider, for example, the disaggregated measures of employment instability (actually, own-industry instability measures). Is there a positive relationship between employment instability and average earnings at the industry (or sectoral) levels within the Western provinces? One might expect the answer to be yes, since labour should normally demand and receive earnings reflecting a risk-premium for employment in a relatively unstable industry. Is there any "conflict" between stability and growth in the sense that those industries experiencing high long-term employment growth are also the most unstable industries in terms of our employment instability measure? More fundamentally, Chapter 3 does not spell out desirable economic goals for a provincial economy. Even if we claim that growth, income and stability are favourable goals for the Western provinces, there are no doubt "trade-offs" between these goals. How should these "trade-offs" be evaluated and reconciled? If all these questions could be answered satisfactorily, only then would we have an analytical framework with a sense of direction.

Some of the above questions can be approached by casual inspection or even partial analysis of the tabular data in Chapter 3. The reader may even wish to perform some simple relational exercises on the data of that chapter. However, on turning to Chapter 4 it becomes apparent that the situation is considerably more complex than it may appear on first inspection. The key difficulty revolves around the measure of employment instability.

We know that provincial employment instability depends not only on the own-industry instability measures, but also on all pairs of cross-industry instabilities. Considering industries (or sectors) in isolation, even within the same provinces, does not reveal the complete story. For example, to reconsider the first question raised in the preceding paragraph, suppose there is a positive relationship between own-employment instabilty and average earnings at the industry level. This relationship, however, only reflects direct effects; all the indirect effects, transmitted through the cross-employment instabilities of the various pairs of industries, are neglected. There would be a similar neglect if the second question raised in the preceding paragraph were approached by means of partial analysis. The neglect of cross-instability effects is not trivial; we already know from Chapter 4 (Table 4-1) that the magnitudes of cross-employment instability dominates the provincial-wide measures of employment instability. A good deal, then, depends upon the relational configuration patterns of different industries' (or sectors') employment fluctuations around trend and these must, somehow, be taken into account for a complete analysis. These relational configurations were discussed in the last chapter under the general heading of economic diversification.

Desirable economic goals for a provincial economy are, by their very nature, provincial aggregates. These aggregates reflect the corresponding disaggregated economic quantities together with the appropriate weights required for aggregation. Before, however, we can even approach the subject of "trade-offs" between provincial economic goals, we must recognize that the aggregation process can differ considerably, depending on the particular goal. In our context, there are two distinct processes. Provincial employment growth and provincial average earnings are each employment weighted averages of the respective corresponding industrial employment growth rates and average earnings. Provincial employment instability, however, does not satisfy such a simple aggregation rule except under very special circumstances (perfect positive correlation of industrially disaggregated employment fluctuations around trend). Employment weights are used to aggregate industrial measures of employment instability, but the weighting process is complex. Most important, the inherent quality of the aggregation process differs critically in the two cases. In the first case (employment growth and employment earnings), the aggregated quantity is always internally bound by the range of corresponding disaggregated quantities. In the second case (employment instability), the aggregated quantity is not subject to such boundary restrictions, except in one very special case. It is perfectly possible and, indeed, desirable for the provincial measure of employment instability to be less than that of the corresponding measure for each disaggregated industry according to the classification used. Even though the aggregation process differs in the two distinguished cases, the processes do have something in common. It is of the utmost importance to note that all provincial aggregates do use employment weights, in one form or another, in the aggregation process. This fundamental point is the key to "putting everything together" in an analytical framework.

With this background we could now briefly discuss the three provincial economic "goals" that fall within our data context.[2] The first goal relates to provincial average earnings (see Table 3-1). In the optimization analysis to follow, it will be assumed that provincial average earnings must be at least maintained when the variables subject to change are manipulated. Since total labour employed in the provincial economies does not change in the analysis to follow, this means that total labour income in the respective provinces is also at least maintained. The implicit assumption, then, is not to sacrifice (historical levels of) total labour income in order to achieve other possible economic goals. It is important to note that provincial labour income may increase, as a result of our optimization analysis, but it will never decrease. The second economic goal relates to provincial employment growth rates (see again Table 3-1). It will again be assumed that the long-term employment growth rate in each Western province must be at least maintained when other variables are altered in the optimization exercises. The growth rate of provincial employment is a positive indicator of the creation and satisfaction of employment opportunities. Once more, the long-term growth of employment opportunities (as evident from historical experience) will not be sacrificed to achieve other economic goals.[3] The first and second economic goals together approximate[4] growth of labour income. Thus, employment growth is not, in fact, an economic goal per se, but achieves economic desirability when combined with the maintenance (at least) of average employment earnings.

The third economic goal, for each province, relates to employment instability. In our optimization analysis, the ultimate objective is to minimize provincial employment instabilty. Why should employment stability be a desirable provincial goal? A provincial economy characterized by relatively large (and frequent) employment fluctuations around trend is more liable to experience the stresses and strains of "boom and bust" cycles. When provincial employment is significantly below trend (cyclical and structural troughs) there are high levels of unemployment. New entrants and re-entrants to the labour force are unable to find employment since the major sectors of the provincial economy are probably on the same (or similar) phase of contraction. At the same time, the provincial economy is probably not sufficiently diversified to permit workers laid off in one industry to easily find employment in other industries, again, if the major industries experience similar employment changes over time. On the other hand, when provincial employment is significantly above trend (cyclical and structural peaks) the economy is sensitive to a number of distortions with long-term effects. Peaks in employment coincide with the existence of employment vacancies as major provincial industries all compete for a limited provincial labour force. When employment vacancies cannot be filled, industries may look for new locations; a more likely effect is the bidding up of wage and salary levels in occupations with the most vacancies. The vacancies may turn out to be temporary, but the locational, expectational and wage-setting impacts may be long-lasting. In fact, the desire for provinces (and even sub-provincial areas) to avoid recurring periods of high unemployment and labour shortages, is precisely the rationale for popular economic programs favouring industrial diversification.[5]

All the elements are now in place to specify the main theme of this chapter -- optimal diversification analysis based on a portfolio analogue. The general idea is to regard each sector's or each industry's employment, within a particular province, as an "investment" in economic resources. We examine sectoral and (manufacturing) industry employment weights, for each province, with a view towards asking what changes in those weights could lessen overall provincial employment instability. The set of historical provincial employment weights, then, serves as the given "portfolio" of investment in economic resources. A set of employment weights, representing a new distribution of employment over the province's sectors and industries, that would minimize provincial employment instability, would then be an "optimal portfolio" of investment in economic resources. The optimization is performed within the given sectoral and industrial classification that forms our data base. We cannot "bring in" entirely new industries for which data are not available.[6] This, however, is not all! The optimization procedure must be subject to a number of constraints. First, there is a danger that employment redistribution, to achieve greater provincial employment stability, may end up "promoting" industries that exhibit relatively low wage and salary levels. This would mean that gains in overall stability could only be obtained at the "cost" of lower overall returns (earnings) to employment (in the portfolio analogue). Thus the optimization procedure is subjected to a constraint that at least maintains (historical) provincial average employment earnings. This constraint is precisely one of our provincial economic goals mentioned above. Second, there is a danger that employment redistribution may tend to favour industries that exhibit relatively low long-term employment growth rates. This means that employment stability gains at the expense of growth in provincial employment opportunities in the long term. Thus optimization must also be subject to a constraint that at least maintains long-term employment growth at the provincial level. This constraint is the provincial economic goal "number two" mentioned above.

There is a third set of constraints, actually boundary limitations, to which optimization is subject. The optimization process begins with the observed (historical) set of employment weights (or employment distribution). It is not economically realistic to claim that a province's employment distribution can be drastically altered, even over the long term. The particular long term, most relevant to this study, is a time period of 13 years. We have been able to measure employment distribution, within each of the Western provinces, towards the beginning and towards the end of the 1970-83 time period. The employment weight results are shown for the sub-periods 1970-72 and 1981-83 in the set of Tables 5-1 to 5-8.[7] Changes in employment weights within each province then give us some idea of reasonable boundary restrictions necessary for the optimization analysis to be "realistic". The restrictions, though, display considerable variety and it seems best to be reasonably flexible in this respect. Also, the boundary restrictions actually utilized in the next two sections are partly motivated to highlight the manufacturing sectors in the four Western Canada provinces.

The main objective function of optimization (employment instability) and the two principal constraints are all integrated via the set of employment weights. Employment redistribution, at the disaggregated level, affects employment instability, earnings and long-term growth at the provincial aggregate level. This key point was already developed at some length earlier in this section. Note that further gains from economic diversification as reflected in employment instability, can only come from employment redistribution within the respective province's industrial classification. This point is best clarified when the results of optimal diversification, subject to constraints, are described and displayed in the next two sections.

Finally, it seems important to emphasize the essential differences between our adaptation of optimal portfolio investment analysis and the traditional applications in financial and related areas. The first major difference was already implicitly discussed: the choice of optimal portfolio (i.e., employment distribution) depends critically on the initial conditions (i.e., the set of historically given employment weights). The reason for this stems from the fact that the boundary limitations imply that only marginal changes in provincial employment distribution are permitted. Initial conditions, however, become less important when a more dynamic approach to optimal portfolio analysis is developed (last section of this chapter). The second major difference involves the idea that our adaptation of portfolio analysis is essentially independent of assumptions concerning risk aversion.[8] Though it is possible to re-interpret our discussion of the employment stability goal along the lines of risk analysis, such interpretation is not necessary. The benefits derived from greater provincial employment stability are reasonably clear, without appealing to the risk characteristics of a provincial social welfare function. A third difference involves the use of multi-linear constraints in the optimization exercise. Traditional portfolio investment analysis uses only one linear constraint -- usually average returns to investment. We use two constraints and a case could be made for adding others. The fourth difference revolves around the choice of objective function. In financial investment analysis it is not always clear what would be the most pragmatic choice of objective function (aside from theoretical considerations that favour the so-called individual (or social) utility function). In our context the choice is clear. This study is mainly concerned with industrial diversification, so the objective function must be employment (in)stability since economic diversification and employment (in)stability are very closely related (this was the main theme of Chapter 4). But this is not all! The minimization of provincial employment instability, subject to constraints, is a much more interesting exercise than, say, the maximization of provincial employment growth or provincial average earnings, also subject to appropriate constraints.[9] The reason for this is that provincial employment instability is capable of real and unusual economic gains, through industrial diversification, that both employment growth and employment earnings cannot obtain. This point was originally stressed early in this section. More important is the fact that employment redistribution to minimize provincial employment instability will not occur "naturally" through market forces and so requires a degree of estimation followed by intervention.[10] On the other hand, free market forces already do tend to maximize growth or incomes, under reasonably competitive conditions. The case for direct estimation and intervention is much weaker. All this, then, summarizes the rationale of our version of optimal portfolio analysis in a provincial industry policy context.

First Set of Empirical Results: Static Scenarios

The data underlying the results of our optimal diversification analysis come from the previous Chapters 3 and 4. For each Western Canada province there are seven non-manufacturing sectors and the manufacturing sector is itself disaggregated into either thirteen, fourteen or fifteen industries, depending on the province involved. All the basic statistical measures for the period 1970-83 are treated as constants with some exceptions. This means that disaggregated sectoral and manufacturing industry long-term employment growth rates and average weekly earnings (Tables 3-7 to 3-10 and Tables 3-18 to 3-21) are all fixed in the following analysis. The sectoral and manufacturing industry employment weights (Tables 3-13 to 3-16 and Tables 3-22 to 3-25) are also fixed, but only in terms of an initial condition. These employment weights are permitted to change marginally as will become evident. Provincial aggregate long-term employment growth and average weekly earnings (Table 3-1) act as constraints and so are not strictly fixed, but may be exceeded. In our particular analysis, provincial aggregate employment levels (also Table 3-1) are implicitly fixed at the average 1970-83 observations. The situation with respect to our measures of employment instability is a little more complicated. In the optimization exercises of this chapter, all disaggregated sectoral[11] and manufacturing industry own-measures of employment instability (Tables 3-13 to 3-16 and Tables 3-22 to 3-25) are assumed to be constant with respect to changes in those variables that are manipulated. The same is true with regard to all disaggregated pairs of cross-employment instabilities (actually shown transformed as non-diagonal correlation coefficients in Tables 4-5 to 4-8 and Tables 4-12 to 4-15). Now recall that provincial aggregate employment instability is a quadratic employment weighted summation of all the disaggregated own-employment instabilities and cross-employment instabilities of the provincial economy.[12] Since the respective sets of (disaggregated) employment weights are permitted to change in the optimization procedures, then provincial (aggregate) employment instability can also change. The historical (1970-83) measures of provincial employment instability (Table 3-2, mid-column) only remain unchanged if it turns out that the status quo is itself optimal. All this is the context within which the optimization analysis "puts everything together".

In effect, then, we take as given, or fixed, the economic structural situation in the various Western provinces as measured from 1970-83 time period observations. We now ask whether it is possible to marginally change the distribution of employment over the various sectors and manufacturing industries so as to minimize provincial employment instability without violating the two constraints with respect to provincial long-term employment growth and provincial average employment earnings. The problem posed is equivalent to asking whether all the "opportunities" for successful economic diversification, subject to constraints, have been exploited. Minimizing provincial employment instability is, evidently, equivalent to maximizing provincial economic diversification, all subject to the same set of constraints, boundary limitations, and the given sectoral and manufacturing industry classification.

Before showing empirical results of the above exercise, it is important to clarify a possible objection to the stated procedure. One may argue that employment redistribution might itself modify the matrix of own- and cross-employment instabilities. Therefore the matrix cannot be considered constant in the optimization analysis, but must be allowed to vary together with the set of employment weights. For this study we have been able to calculate only one matrix of employment instabilities for each province, representing the long-term experience of the period 1970-83. If the provincial industrial experience of another long-term period were available, say 1957-70, it would then be interesting to compare changes in the respective matrix elements. There is no doubt that such matrices do change over different long-term time periods and some relevant discussion of this matter can be found in Chapter 6. For the present purposes, however, it seems reasonable to consider the instability matrices to be constant with respect to marginal changes in provincial disaggregated employment weights. We already know (see again Chapter 6) that a major factor responsible for changes in the matrix elements is employment redistribution within the various sectors and manufacturing industries of our given classification. Such changes in employment mix, at an even finer level of disaggregation, are ruled out of our procedures. It should also be noted that all elements of the provincial employment instability matrices are scaled with respect to their relevant (average) employment levels. So if one industry becomes more important than another industry, in terms of optimal employment redistribution, there is no clear reason for employment instability to also change at the industrial level since scaling factors per se are already implicitly taken into account.[13] We should add that if the matrix elements are permitted to shift as a result of variations in employment distribution, then one must specify the precise nature of the associated relationship. There is no experience nor are there obvious assumptions that can be made concerning this matter. Finally, our simplifying approach to the problem of optimal diversification analysis has two essential advantages: (1) a possible solution to the problem is already guaranteed, namely the status quo[14] and (2) the optimal solution has the desirable property of being a global (constrained) solution (and not just a local (constrained) solution unduly reflecting initial conditions.)[15]

The empirical results of our optimum diversification analysis have been run on the basis of three scenarios. Each scenario represents a different set of boundary limitations to which provincial employment redistribution is subject. All scenarios begin with the historically given employment distribution (or set of employment weights) as observed over the full time period 1970-83. For the readers' convenience these weights, originally presented in Chapter 3, are repeated in Tables 5-1 to 5-8, third column. In this section we will be mainly concerned with tracing the changes in employment distribution that result from constrained optimal diversification, using the portfolio analogue. The scenarios in this section are of the "static" variety; their "dynamic" counterparts are described in the next section of the chapter. Also, it will be found instructive to show the results for each scenario in two stages. In the first stage the optimization procedure is subject only to the particular scenario's boundary limitations; the two major constraints (employment growth and employment earnings) are absent. The first stage will be called "partially constrained" optimization. In the second stage, the two major constraints are effectively present together with the scenario's boundary limitations. Hence the second stage is known as "fully constrained" optimization. Our prime concern is with the full results of the second stage, but the route by which the second stage is reached should be of interest in interpreting the results. One other, rather obvious, point is that all scenarios and stages are implicitly subject to the distribution identity constraint that all (optimal) employment weights must sum to 100 per cent.

Consider now the set of Tables 5-9 to 5-16. There are three scenarios each the result of partially constrained optimization. The employment distribution resulting from each scenario should be compared with the corresponding initial employment distribution from one of the Tables 5-1 to 5-8, third column. In scenario number one, the rules of the game are as follows. Each non-manufacturing sector and manufacturing industry is permitted to increase its employment weight by at most 25 per cent. At the same time, no sector or industry is permitted to decrease its employment weight by more than 25 per cent. In effect this means that the "upper bounds" on employment distribution equal 1.25

multiplied by the corresponding sectoral employment weights and manufacturing industry employment weights of the Tables 5-1 to 5-8, third column. The "lower bounds" on employment distribution equal 0.75 multiplied by the same corresponding employment weights of the previous tables. In scenario number two, the rules of the game are different. Each non-manufacturing sector is permitted to decrease its employment by no more than the factor 0.75 while the same sectors are not permitted any increase in employment weight ("upper bound" factor equals 1.0). The manufacturing industries, on the other hand, are permitted to increase employment weight by at most 25 per cent, but any decrease in employment weight is disallowed. Thus, in scenario one, the boundary limitations are essentially neutral with respect to manufacturing; in scenario two there is a distinct bias favouring manufacturing. In fact, in scenario two, any employment distribution changes for non-manufacturing must be "losses" (relatively speaking) while any such redistribution with respect to manufacturing must be "gains" (relatively speaking). Manufacturing is favoured in scenario two in order to highlight the potential of the Western provinces' manufacturing industries -- an important purpose of this study (see again Chapter 1).

Scenario two, though, is still neutral within manufacturing. It is desirable to have a scenario that favours secondary manufacturing industries within the respective provinces' manufacturing sectors. This goal is achieved by scenario number three. The rules of the game are now the same as those in scenario two with respect to non-manufacturing sectors and non-secondary manufacturing industries (i.e., local manufacturing, primary manufacturing and the residual manufacturing industries). The secondary manufacturing industries, specified for each Western province (see the third section of Chapter 3), are now permitted to increase their employment weights by at most a factor equal to 2.5, while again no decrease in their employment weights are allowed. The "upper bound" factor of 2.5 might seem unrealistic, but there are already some examples of such an employment redistribution magnitude towards specific secondary manufacturing industries between the sub-periods 1970-72 and 1981-83.[16] The main motivation, however, underlying scenario three is to test the potential of Western Canada's secondary manufacturing industries (further discussion in Conclusion Chapter 6).

The set of Tables 5-9 to 5-16 will not be explicitly analyzed here since the results are primarily a stepping-stone to the results of fully constrained optimization given in the next set of Tables 5-17 to 5-24. There is, though, some discussion of the partially constrained optimization in the next section where we are explicitly concerned with the "cost" of the full constraints relative to the partial constraints. For the present we will concentrate on comparing the optimal employment distributions resulting from the three scenarios in Tables 5-17 to 5-24 with the initial employment distributions, namely the status quo of Tables 5-1 to 5-8, third column.[17] It is not possible, in the confines of this study, nor is it necessary to make all possible comparisons for all provinces. We will emphasize employment redistribution with respect to manufacturing and consider Manitoba and Alberta in more detail than the other Western provinces. The reader should then be able to make any other comparisons, along the following lines, that might be of particular interest.

Consider first the Manitoba fully constrained scenario one (Tables 5-17 and 5-18, first column). The resulting set of employment weights should then be compared[18] with the initial employment distribution (Tables 5-1 and 5-2, third column). It is evident that the sectors manufacturing, transportation & communication & utilities (TCU), trade, and finance & insurance & real estate (FIRE) all "gain" marginally from optimal diversification -- their employment weights are now higher compared to the initial distribution. Conversely, the mining, construction and commercial services sectors emerge as "losers" -- their respective employment weights become lower following the optimization procedure. This means that Manitoba employment instability can be decreased by the stated kind of marginal employment redistribution without sacrificing Manitoba long-term employment growth or employment average earnings (as observed during the 1970-83 time period). Within Manitoba's manufacturing sector there are some clear "winners" and "losers". For example, the industries food & beverages, printing & publishing, clothing, electrical products, and residual manufacturing all end up with greater employment weights. On the other hand, primary metals, metal fabricating, machinery, and transportation equipment industries become less important in terms of relative employment. There is then a considerable redistribution of employment, marginally speaking, within Manitoba's manufacturing sector. The net employment result, though, for Manitoba manufacturing as a whole is a marginal gain in employment weight from 25.4 per cent to 26.4 per cent. It should be noted that this gain for manufacturing is obtained under the rules of the game in a scenario that is essentially "neutral" with respect to the various sectors and industries in our classification.

Before briefly considering other scenarios and other provinces, it seems instructive to attempt some "explanation" of the above results. The reader, though, should be warned that a "rigorous" explanation is not possible; there are too many interacting ingredients involved, each checking and balancing against the other, to give more than a general intuitive explanation of what appear to be the main factors responsible for the results.[19] Let us use the partially constrained set of employment weight results (Tables 5-9 and 5-10, first column) as a stepping-stone towards explanation. (Indeed, the partially constrained results are almost identical to the fully constrained results (Tables 5-17 and 5-18, first column).) Referring back to Tables 3-13 and 3-22, giving own-sectoral and own-industry employment instability measures for Manitoba, it is not difficult to see that the mining and construction sectors should become employment "losers"; the same is true with respect to primary metals, machinery and transportation equipment manufacturing industries. All these sectors and industries have relatively high measures of own-employment instability. For further clarification, we need to refer to the matrices of cross-employment instabilities (transformed into correlation coefficients) for Manitoba, namely Tables 4-5 and 4-12. It is evident that commercial services (employment fluctuations) is positively correlated with all other sectors and all manufacturing industries, so commercial services' employment does not offer significant benefits in terms of countervailing-effects required for successful economic diversification. On the other hand, FIRE is negatively correlated with eight manufacturing industries and virtually zero correlated with the TCU sector which has a large initial employment weight. The trade sector also has some properties reminiscent of FIRE, and evidently more favourable than the TCU sector. These are all indirect effects which serve to promote FIRE and trade as indirect sources of provincial employment stability, while commercial services and TCU tend to have opposite effects that reinforce Manitoba employment instability. Further examination of Table 4-12, along the above lines, would indicate why clothing, electrical products, and chemical products turn out to be "winners" in terms of employment redistribution designed to minimize provincial employment instability. Note that Manitoba's clothing manufacturing industry is virtually zero correlated, in terms of employment fluctuations around trend, with the two most important non-manufacturing sectors in that province, namely TCU and trade. In addition, clothing is negatively correlated with the province's construction and FIRE sectors. All this, then, would tend to explain the results of partially constrained optimization, Tables 5-9 and 5-10, first column -- our "stepping-stone". Now the only difference between the results of the preceding tables and those of fully constrained optimization (Tables 5-17 and 5-18, first column) relate to the sectors TCU and trade. As a result of fully constrained optimization the Manitoba TCU sector employment gains (relative to partially constrained optimization) and the Manitoba trade sector employment loses (again relative to partially constrained optimization). Can these counter-acting employment changes be "explained"? We think they can! The explanation can be found in the imposition of the constraint relating to provincial employment average earnings. Turning back to Table 3-7 it is seen that average weekly earnings in Manitoba's TCU sector ($262) is considerably higher than average weekly earnings in the trade sector ($167). In the partially constrained scenario one, the resulting employment gains for Manitoba's trade sector (and losses for the TCU sector) would force a violation of the provincial employment earnings constraint. In order, therefore, to meet the additional constraint, there must be some reversal of employment redistribution between the two sectors and this is precisely accomplished once the constraint is enforced. It might be added, that the provincial long-term employment growth constraint, also formally imposed in Tables 5-17 and 5-18 (first column), has no effect on the results, relative to Tables 5-9 and 5-10 (first column) since we know from algorithmic analysis that this particular constraint is not binding in this context (seen later).

The foregoing paragraph may provide the reader with an idea of why a systematic analytical framework is needed to "put everything together". The fully constrained optimization exercise is specifically oriented towards this purpose. At the same time, the paragraph may provide some rationale for why we are unable to offer a similar series of "explanations" for each and every scenario and province. Instead, we will merely summarize some highlights most relevant to the study. Scenario two in the Manitoba Tables 5-17 and 5-18 is designed to favour manufacturing. This is clearly evident from the results, upon comparison with the initial employment distribution in the Manitoba Tables 5-1 and 5-2, third column. Manufacturing sector employment jumps to 29.9 per cent of total employment compared to the initial 25.4 per cent. This gain is again made at the expense of the mining, construction and commercial services sectors. Note that the TCU, trade, FIRE sectors are no longer "winners", as they were in scenario one; in the present scenario two, all non-manufacturing sectors are not allowed to gain in terms of employment redistribution; these sectors can "at most" retain their status quo -- which is precisely what happens to the TCU, trade and FIRE sectors of Manitoba. At the same time, of course, in scenario two individual manufacturing industries cannot become "losers", but may gain at most what was achievable in scenario one. Transportation equipment industry, which lost relative employment in scenario one, now gains from employment redistribution in scenario two. Moving to scenario three in Tables 5-17 and 5-18 does not result in significant changes, at least compared to the previous scenario two.

Total manufacturing employment goes up slightly more, at the expense of TCU (a net "loser" compared to initial conditions) and commercial services. Since scenario three is designed to favour secondary manufacturing industries within the total sector, there are further gains in terms of employment redistribution for clothing, electrical products and chemical products. Indeed, some of these gains are made at the expense of transportation equipment which reverses to its initial employment position. Note that both electrical products and chemical products reach the maximum employment redistribution position allowed by scenario three; this is not true for the clothing manufacturing industry -- evidently suppressed by the industry's very low level of average earnings (Table 3-18). This is a good indication of how the constraint on provincial average earnings acts to hold back the employment promotion of certain industries, lest the constraint be violated. Both electrical products and chemical products are characterized by relatively high average earnings (again Table 3-18), so their employment promotion is congruent with the provincial-wide goal of not sacrificing average earnings levels to minimize provincial employment instability.[20] Finally it might be added that even though scenarios two and three are designed to promote manufacturing sector employment, any gains in such employment must be "earned" in the sense that there results a decrease in provincial employment instability without violating the two major constraints.

We will now briefly discuss the Alberta Tables 5-21 and 5-22 (fully constrained optimization) compared to the province's initial employment weights as in Tables 5-5 and 5-6, third column. It is now evident that the "case" for promoting manufacturing in order to lower provincial employment instability is weaker in Alberta than in Manitoba, though the "case" is still possible! In the perfectly "neutral" scenario one, the manufacturing sector share of employment becomes lower as a result of fully constrained optimization to minimize Alberta employment instability; the manufacturing employment weight becomes 14.6 per cent compared to the initial allocation of 16.6 per cent. The construction and commercial services sectors also end up with less (relative) employment; the major "winners" are TCU, trade and FIRE. Within Alberta manufacturing there are still some gains for employment -- printing & publishing, chemical products and residual manufacturing; petroleum & coal products is a marginal "loser" of employment. In order to achieve net gains for Alberta's manufacturing sector, it is necessary to explicitly favour manufacturing and this is done in scenario two and three. The manufacturing share of employment rises to 18.1 per cent and 19.6 per cent respectively compared to the initial situation of 16.6 per cent. It is of the utmost importance to again note that these employment gains for Alberta's manufacturing sector result in a decrease in provincial employment instability (the magnitude of the decrease is shown in the next section) and yet do not violate the two major provincial goal constraints. There are two Alberta manufacturing industries primarily responsible for this coincidence -- electrical products and chemical products. When manufacturing is explicitly favoured (scenarios two and three), then the non-manufacturing sectors such as TCU, trade and FIRE are no longer permitted to gain in terms of employment weight. Surprisingly, however, the relative position of commercial services is virtually restored when manufacturing is favoured. This particular result is a good example of the counter-intuitive nature of some of the findings -- there are a large number of interacting factors that are difficult to diagnose. Finally we note that the mining sector of Alberta does not become an employment loser in our scenarios (except for a marginal loss in scenario one). This result may also seem to be counterintuitive since Alberta's mining sector experiences a high degree of own-employment instability (Table 3-15). The explanation, however, can be found in the two major constraint relationships; both the employment growth rate and the average earnings level of Alberta's mining sector are the highest in the province (Table 3-9); if the mining sector employment is surpressed, there is grave danger that the two provincial goal constraints will be violated. Hence the mining employment weight remains constant even though it is certainly permitted to decrease.[21] This explanation is evident from observing the employment weight results for mining (and manufacturing) in the partially constrained scenarios of Alberta's Tables 5-13 and 5-14.

Finally, the two sets of Tables 5-19 and 5-20 (Saskatchewan) and Tables 5-23 and 5-24 (British Columbia) have much in common with the situation in Alberta, particularly with respect to manufacturing. Some differences, though, will become apparent in the further analysis of the next section and the policy implications of the concluding chapter.

Second Set of Empirical Results: Dynamic Scenarios and Summary

All the scenarios of the previous section began with the initial set of employment weights as observed for the time period 1970-83. Then, in the spirit of portfolio analysis, we inquired whether the various Western provinces might be "better off" with an alternative distribution of investment in employment resources, noting at the same time that the alternative mix must satisfy certain boundary limitations and two major economic goal constraints. The boundary limitations, which differ from scenario to scenario, all stem from the initial distribution of employment over the respective provinces' sectors and manufacturing industries. The optimal (constrained) solution of the portfolio analysis yields a new (supposedly "better") set of employment weights. In the previous section it was mentioned that this general type of portfolio "investment" analysis is essentially *static*. We could not outline the *dynamic* counterpart of our modified version of portfolio analysis.

The dynamic counterpart considers the scenarios of the preceding section as the first *iteration* of a possible multi-iteration procedure. In the second iteration, we would begin with the optimal solution (i.e., distribution of employment resources) obtained from the first iteration. Then, again introducing a set of boundary limitations and the two major goal constraints, the quadratic programming algorithm is deployed to yield a new optimal solution -- representing the "best" employment mix stemming from the solution of the first iteration (which itself stemmed from the initial historical employment distribution). The boundary limitations, to which the second iteration is subject, can be chosen precisely along the lines of the previously stated scenarios one, two and three. Moreover, the two major goal constraints are simply re-used. We do not have goal constraint data for another long-term period, say, 1983-1996. So the second iteration is dynamic in terms of procedure, but not necessarily dynamic in terms of substance.[22] A key question is: will the second iteration yield a solution that is different from and "superior" to the solution of the first iteration? The answer is, almost certainly, yes! The reason comes essentially from the existence of effective boundary limitations. In the second iteration the original boundary limitations imposed on changes in employment distribution, are indirectly loosened. This permits greater industrial flexibility of employment mix to minimize provincial employment instability (examples are given later in this section). If optimal portfolio analysis were run without boundary limitations, but still with economic goal constraints, then the solution obtained from the first iteration could not be "improved" by further iterations. If boundary limitations are absent, then the procedure would have little economic meaning. We think that a multi-iteration procedure with boundary limitations, that effectively "removes" such boundary limitations in carefully designed steps, does have some economic meaning (although still requiring policy interpretation, as in Chapter 6). Before continuing it should be noted that once dynamic scenarios are introduced, there are many possibilities for running such programs. Clearly, a third and more iterations can be added. It is also possible to "mix" scenarios by running, say, scenario one in the first iteration and following with scenario two in the second iteration. The programmer, could even modify the provincial aggregate quantity constraints in the two major economic goal constraints from one iteration to the next. In the following, though, we stick to reasonably homogeneous examples.

The new set of Tables 5-25 to 5-32 shows the results of dynamic optimization to minimize employment instability in the four provinces of Western Canada. All these results of employment redistributions are the second iteration corresponding, scenario by scenario and province by province, to the previous set of results, Tables 5-17 to 5-24. There are no "mixed" cases here; each scenario of a particular type is applied twice and the full goal constraints are re-used without modification. Generally speaking, the new set of results are characterized by a continuation of the employment distribution changes first noted with respect to the original (Tables 5-17 to 5-24) set of results. In effect, the results of Tables 5-25 to 5-32 reflect more liberal boundary limitations, each scenario in its own characteristic way.

We will not, however discuss the new set of tables in detail. The reader most interested in particular provinces and particular scenarios could easily fill in the details, using the guidelines so far offered in this chapter. We are, essentially, most interested in the results of second iterations, or even third iterations, in terms of their potential for lowering provincial measures of employment instability, at least in the very long-term. These considerations now call for some extended discussion. However, before actually dealing with this main concern, a preliminary point of some importance must be clarified.

It was already mentioned earlier that the two economic goal constraints are not always "binding". This essentially means that a particular constraint condition (e.g., the maintenance, at least, of provincial long-term employment growth as observed during the period 1970-83) may be satisfied after optimization without its formal imposition. In effect, employment redistribution to minimize provincial employment instability does not conflict with one (or even both) of the provincial economic goal constraints. The optimal solution would be the same whether or not the particular constraint was imposed. In this case, then, we need not worry about a possible trade-off between provincial employment (in)stability and, say, provincial long-term employment growth (at least in the neighbourhood of the latter quantity constraint). Similar remarks may apply to the other economic goal constraint used in this study -- the maintenance, at least, of provincial average weekly earnings at this aggregate level (based on 1970-83 observations). It should be noted, however, that whether or not a particular economic goal constraint is "binding" depends on the rules of the game under which optimization (to minimize provincial employment instability) is played. In other words, the impact of the constraint can vary with the scenario which itself depends on the boundary limitations to which employment redistribtuion is subject. There are, therefore, no "global" answers to whether or not an economic constraint is binding; answers can be given "in the neighbourhood" of our examples to follow.

A new set of Tables 5-33 to 5-36, one for each Western province, illustrates the above situation with respect to the various scenarios, static and dynamic, performed in this study. The scenarios are precisely the ones described in the last section and earlier in this section of the chapter. The tables do not cover the "partially constrained" scenarios of the last section (Tables 5-9 to 5-16) since these are not relevant. On the other hand, the tables cover dynamic scenarios, both those shown earlier (Tables 5-25 to 5-32) and a further set of dynamic scenarios representing a "third iteration" (not shown in terms of disaggregated results of employment weights). In each of the new set of Tables 5-33 to 5-36, we simply indicate by "yes" or "no" whether the relevant economic goal constraint for a particular province "is" or "is not" binding for the scenario involved.[23] In most individual cases the constraints are binding. Indeed there are almost no cases (scenarios) in which both constraints are simultaneously not binding![24] This means that the imposition of at least one of the two economic goal constraints almost always acts in such a way to make it "more difficult" to obtain gains in terms of greater provincial employment stability. (The effective quantitative nature of the constraint will be shown later in this section.) Typically, then, there is a trade-off (or one might say "conflict") between provincial employment stability, on the one hand, and provincial long-term employment growth and provincial average employment earnings, on the other hand. If both the latter economic goal constraints were relaxed, it would typically be possible to obtain greater provincial employment stability from, appropriately bounded, employment redistribution. Furthermore, it would appear from the tables, that the province of Alberta is particularly restricted by the two economic goal constraints (both are always binding, with one minor exception). Manitoba is significantly less restricted than Alberta in this respect. Of the two economic goal constraints, the one referring to the maintenance of provincial long-term employment growth is more often non-binding compared to the other. All these, of course, are purely qualitative relationships. We now turn to the important corresponding quantitative relationships and implications.

The final set of Tables 5-37 to 5-40 embody what are probably the most important results of the study. These tables specifically show the impact of constrained optimization on the respective provincial employment measures of instability (so far we have only shown the impact on employment distribution). The tables cover all scenarios, both static and dynamic, both partially constrained and fully constrained.[25] For comparative convenience, the tables include the status quo measures of provincial employment instability originally presented in Table 3-2, mid-column. The purpose of our optimal portfolio analysis (or, equivalently, optimal diversification analysis) is to "improve upon" the status quo without violating economic goal constraints and employment redistribution boundary limitations. Indeed, the status quo is one possible solution to our quadratic programming algorithm. Inspection of the new set of tables shows, however, that the status quo in each Western province is inefficient.[26] It is possible to lower provincial measures of employment instability (i.e., lower than the status quo) without sacrificing other economic goals; this is obtained via the minimization operation by marginally changing employment distribution. In effect, the minimization (constrained) operation puts each Western province on its efficiency frontier with respect to the three provincial economic goals of employment stability, employment average earnings and long-term employment growth. The movement, in fact, to the efficiency frontier is independent of whether or not the two latter economic goals act as effective ("binding") constraints. Indeed, if one of the two latter goals is not binding, then the programming operation yields gains both in terms of provincial employment instability and in terms of the provincial quantity indicator relevant to the non-binding constraint. The movement to the efficiency frontier is, however, dependent on the rules of the game of the various scenarios. Some rules yield efficiency points (i.e., minimum obtainable provincial employment instability) that are "superior" to other rules; still other sets of rules are, generally, non-comparable. We can now specifically discuss the highlights of Tables 5-37 to 5-40.

First consider Table 5-37 for Manitoba. The status quo measure of employment instability equals .0337. Partially constrained scenario one lowers the instability measure to .0309; the fully constrained (static) counterpart results in .0313. The difference, then, between the two measures illustrates the implicit "cost" of the full constraints (actually the employment growth constraint is not binding) in terms of a higher level of employment instability than otherwise. Similar remarks apply to the other scenarios upon comparing partially constrained to fully constrained results. Our main interest, as usual, is in the fully constrained results to which exclusive attention will now be drawn. In scenario two, Manitoba employment instability becomes .0324, higher than scenario one because the rules of the game are more restrictive in scenario two compared to scenario one. In scenario three, Manitoba employment instability measures .0317, lower than scenario two since the rules of the game are less restrictive in scenario three as compared to scenario two. At the same time, the result for scenario three is higher than that of scenario one, but this relationship is not general since the rules of the game in scenario three are non-comparable to those in scenario one. Finally, we consider the impact of the dynamic scenarios. In all cases, the results of the second iteration are lower than the corresponding results for the first iteration and similarly with respect to the third iteration when compared to the corresponding second iteration. Indeed, we find that by the third iteration, the "neutral" scenario one results in a provincial employment instability equal to .0273; the third iteration for scenario three ("favouring" manufacturing and particularly secondary manufacturing) results in a Manitoba employment instability equal to .0262. Both these measures are now lower than the status quo employment instability measure for Ontario (equal to .0287 as in Table 3-2, mid-column). To summarize, we might say that it is potentially possible to significantly lower Manitoba's employment instability by optimal industrial diversification of employment resources. Major gains, however, are not generally obtained until the "third iteration" -- which is essentially a very long-term prospect at best. There are, nevertheless, still other possibilities discussed in Chapter 6.

Table 5-38 for Saskatchewan can be analyzed in a strictly analogous manner. We can see that the status quo measure of employment instability equal to .0409 can be "eventually" lowered to .0318 via the neutral scenario one or to .0289 via the secondary manufacturing biased scenario three. Both these measures are of the same order-of-magnitude for Ontario's status quo and actually lower than Quebec's present measure of .0328 (Table 3-2, mid-column). Next consider Table 5-39 for Alberta. We already know that Alberta's present employment instability is the highest of all six provinces, equal to .0541.[27] It should, therefore, be particularly important to try to lower this province's employment instability by means of an optimally diversified employment redistribution. There is evidence, however, that the imposition of the two economic goal constraints (based on 1970-83 observations) is particularly "expensive" to this province in terms of employment instability. This evidence is apparent upon comparing the results of partially constrained optimization with the corresponding results of fully constrained optimization (static scenarios only). There is a larger "gap" in terms of measured employment instability between the two sets of scenarios for Alberta compared to the other Western provinces. Moreover, there is clear evidence that the "neutral" scenario one is capable of reaching employment instability results significantly more desirable than results reached by the secondary manufacturing "favoured" scenario three; the former reaches .0449 in the third iteration while the latter is still at .0485. Neither measure, of course, is near the Ontario or even the Quebec status quo. The situation for Alberta, then, requires further analysis and this will be attempted in the next chapter. In the meantime it would appear that the manufacturing "route" to obtaining greater provincial employment stability would be a difficult one for Alberta. Finally, Table 5-40 for British Columbia has elements common to both Manitoba and Alberta. It is possible to eventually lower British Columbia's employment instability from the present measure of .0416 to .0316 ("neutral" scenario one, iteration three) which is between Ontario and Quebec. But the secondary manufacturing favoured route (scenario three, iteration three) is again difficult, registering an employment instability measure equal to .0387 even after three iterations.

Notes

1 See again Chapter 2 for the coverage of the larger-firm survey and related conceptual discussion.

2 It is certainly possible to specify other desirable provincial goals that are outside our data limitations; see further discussion in Chapter 6 and also Chapter 2.

3 Some complications, though, do arise with respect to this particular goal (seen later in the study).

4 The approximation holds on the basis of reasonable assumptions (see Appendix B).

5 First mentioned in Chapter 1. These "boom and bust" cycles also have profound impacts on provincial population and related aspects through immigration and emigration; see Economic council of Canada (1984).

6 Some exceptions, however, can be made as seen in the next section and Chapter 6.

7 These sets of employment weights also underlie Table 4-10 of the previous chapter.

8 The best single reference on the subject is Tobin (1965). A more contemporary treatment is Markowitz (1983).

9 One of the constraints would then involve provincial employment instability, maintained at most at observed levels.

10 These points are discussed, together with the study's policy implications, in Chapter 6.

11 "Sectoral", in this section and the next, should always be understood as meaning "non-manufacturing sectoral".

12 A more precise statement can be found in Appendix A.

13 See the formulation in Appendix A.

14 This is an "existence" requirement, often overlooked in similar formulations.

15 The proof is given in Mathematical Appendix A.

16 Employment redistribution of about this magnitude works best when the initial employment weights are very small (as they usually are for most secondary manufacturing industries in Western Canada, according to our industrial classification).

17 All tabular employment weights are shown rounded to the nearest decimal point; unrounded weights were used in all estimation procedures.

18 The forestry sector of Manitoba (and also Saskatchewan and Alberta) was held constant (no change in employment weight) for technical reasons discussed in Chapter 2.

19 All constrained optimization procedures follow from a quadratic programming algorithm described in Appendix A. Most employment weights end up at their boundaries, either upper or lower, but there are important exceptions. Complications also arise from the fact that the two given constraints are not always binding (see next section).

20 The two manufacturing industries also appear to be congruent with the goal of not sacrificing Manitoba long-term employment growth opportunities since their individual employment growth rates (Table 3-18) are both above average. Further discussion along these lines can be found in the next chapter.

21 This point is further discussed, with other tabular results, in Chapter 6.

22 Similarly, the scaled covariance matrix of own- and cross-employment instabilities is simply re-used in the second iteration.

23 The simple "yes" and "no" dichotomy conceals the magnitude of an effective constraint's binding power, revealed by a corresponding "shadow price" (or Lagrangian multiplier) analysis; see discussion in Appendix A.

24 The only exceptions come from the dynamic (third iteration) scenarios.

25 We have not run any dynamic scenarios that are "partially constrained".

26 There is no doubt that a similar analysis would show that the status quo in the two Central Canada provinces is also "inefficient".

27 It should again be noted that this result comes from the larger-firm survey coverage, although the addition of agriculture does not greatly alter the relative situation for Alberta (see again Chapter 3).

Table 5-1

Sectoral Employment Weights, 1970-72, 1981-83 and 1970-83, Manitoba

Sector	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Forestry	0.4	0.6	0.5
2. Mining	4.3	2.6	3.4
3. Manufacturing	25.5	24.4	25.4
4. Construction	5.1	2.7	4.2
5. Transp'n, Comm'n, Utilities	24.9	23.0	23.5
6. Trade	22.3	24.2	22.9
7. Finance, Insurance, Real Estate	6.6	8.4	7.3
8. Commercial Services	10.8	14.2	12.8

Table 5-2

Manufacturing Industry Employment Weights, 1970-72, 1981-83 and 1970-83, Manitoba

Industry	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Food & Beverages	5.7	4.5	5.1
2. Printing & Publishing	2.0	1.9	1.9
3. Wood Products	0.6	0.9	0.8
4. Paper & Allied Industries	1.1	1.2	1.2
5. Primary Metals	1.6	1.1	1.4
6. Non-Metallic Mineral Products	0.6	0.6	0.6
7. Clothing	3.5	3.0	3.4
8. Furniture & Fixtures	0.8	0.9	0.8
9. Metal Fabricating	2.2	2.0	2.2
10. Machinery	1.5	2.3	2.1
11. Transportation Equipment	2.6	3.0	2.8
12. Electrical Products	1.0	1.1	1.0
13. Chemical Products	0.5	0.5	0.5
14. Residual Manufacturing	1.7	1.4	1.6
Total Manufacturing	25.5	24.4	25.4

Table 5-3

Sectoral Employment Weights, 1970-72, 1981-83 and 1970-83, Saskatchewan

Sector	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Forestry	0.7	0.5	0.7
2. Mining	6.4	7.2	6.4
3. Manufacturing	15.8	13.8	15.1
4. Construction	6.5	4.3	5.6
5. Transp'n, Comm'n, Utilities	27.3	22.9	24.7
6. Trade	25.5	27.1	26.4
7. Finance, Insurance, Real Estate	7.6	10.2	8.8
8. Commercial Services	10.2	14.0	12.4

Table 5-4

Manufacturing Industry Employment Weights, 1970-72, 1981-83 and 1970-83, Saskatchewan

Industry	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Food & Beverages	6.4	4.1	5.0
2. Printing & Publishing	1.4	1.3	1.2
3. Wood Products	1.2	1.1	1.3
4. Paper & Allied Industries	0.7	0.5	0.6
5. Primary Metals	1.3	1.6	1.5
6. Petroleum & Coal Products	0.8	0.3	0.5
7. Clothing	0.4	0.4	0.6
8. Metal Fabricating	0.9	1.0	1.1
9. Machinery	0.7	1.2	1.2
10. Transportation Equipment	0.2	0.3	0.4
11. Electrical Products	0.4	0.7	0.5
12. Chemical Products	0.3	0.3	0.3
13. Residual Manufacturing	1.1	1.2	1.1
Total Manufacturing	15.8	13.8	15.1

Table 5-5

Sectoral Employment Weights, 1970-72, 1981-83 and 1970-83, Alberta

Sector	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Forestry	0.5	0.4	0.5
2. Mining	8.8	11.5	10.0
3. Manufacturing	18.6	14.2	16.6
4. Construction	9.7	8.7	8.9
5. Transp'n, Comm'n, Utilities	19.3	17.7	18.1
6. Trade	21.9	21.7	22.4
7. Finance, Insurance, Real Estate	6.8	8.5	7.6
8. Commercial Services	14.3	17.2	15.9

Table 5-6

Manufacturing Industry Employment Weights, 1970-72, 1981-83 and 1970-83, Alberta

Industry	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Food & Beverages	5.1	3.4	4.1
2. Printing & Publishing	1.0	1.1	1.0
3. Wood Products	1.7	0.8	1.4
4. Paper & Allied Industries	0.6	0.6	0.6
5. Primary Metals	1.1	0.9	1.0
6. Non-Metallic Mineral Products	1.2	1.1	1.3
7. Petroleum & Coal Products	0.6	0.8	0.7
8. Clothing	0.7	0.4	0.6
9. Furniture & Fixtures	0.4	0.3	0.3
10. Metal Fabricating	1.8	1.4	1.6
11. Machinery	0.8	0.9	0.8
12. Transportation Equipment	1.2	0.6	1.0
13. Electrical Products	0.4	0.3	0.4
14. Chemical Products	1.0	1.1	1.0
15. Residual Manufacturing	0.9	0.7	0.7
Total Manufacturing	18.6	14.2	16.6

Table 5-7

Sectoral Employment Weights, 1970-72, 1981-83 and 1970-83, British Columbia

Sector	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Forestry	3.9	2.5	3.5
2. Mining	3.0	3.1	3.0
3. Manufacturing	30.9	25.2	28.5
4. Construction	5.3	4.6	4.7
5. Transp'n, Comm'n, Utilities	20.1	20.0	19.9
6. Trade	18.6	19.5	19.2
7. Finance, Insurance, Real Estate	6.3	9.0	7.6
8. Commercial Services	11.8	16.0	13.5

Table 5-8

Manufacturing Industry Employment Weights, 1970-72, 1981-83 and 1970-83, British Columbia

Industry	1970-72 Weight	1981-83 Weight	1970-83 Weight
		(Per cent)	
1. Food & Beverages	4.2	3.7	3.9
2. Printing & Publishing	1.2	1.3	1.2
3. Wood Products	10.4	7.4	9.4
4. Paper & Allied Industries	4.7	4.1	4.4
5. Primary Metals	2.1	1.7	1.8
6. Non-Metallic Mineral Products	0.8	0.7	0.7
7. Petroleum & Coal Products	0.3	0.2	0.2
8. Clothing	0.6	0.5	0.5
9. Furniture & Fixtures	0.3	0.2	0.3
10. Metal Fabricating	1.8	1.4	1.7
11. Machinery	0.8	0.8	0.8
12. Transportation Equipment	1.3	1.4	1.5
13. Electrical Products	0.7	0.6	0.7
14. Chemical Products	0.7	0.5	0.6
15. Residual Manufacturing	0.9	0.7	0.8
Total Manufacturing	30.9	25.2	28.5

Table 5-9

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Manitoba

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	2.5	2.5	2.5
3. Manufacturing	26.4	29.0	35.1
4. Construction	3.2	3.2	3.2
5. Transp'n, Comm'n, Utilities	20.1	23.5	18.9
6. Trade	28.6	22.9	22.9
7. Finance, Insurance, Real Estate	9.1	7.3	7.3
8. Commercial Services	9.6	11.1	9.6

Table 5-10

Manufacturing Industry Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Manitoba

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	6.4	6.4	6.4
2. Printing & Publishing	2.4	2.4	2.4
3. Wood Products	0.6	0.8	0.8
4. Paper & Allied Industries	1.5	1.5	1.5
5. Primary Metals	1.0	1.4	1.4
6. Non-Metallic Mineral Products	0.5	0.6	0.6
7. Clothing	4.2	4.2	8.4
8. Furniture & Fixtures	0.6	0.8	0.8
9. Metal Fabricating	1.7	2.2	2.2
10. Machinery	1.6	2.1	2.1
11. Transportation Equipment	2.1	2.8	2.8
12. Electrical Products	1.2	1.2	2.5
13. Chemical Products	0.6	0.6	1.2
14. Residual Manufacturing	2.0	2.0	2.0
Total Manufacturing	26.4	29.0	35.1

Table 5-11

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Saskatchewan

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.7	0.7	0.7
2. Mining	4.8	4.8	4.8
3. Manufacturing	15.0	18.1	19.4
4. Construction	4.2	4.2	4.2
5. Transp'n, Comm'n, Utilities	22.0	24.7	24.7
6. Trade	33.0	26.4	26.4
7. Finance, Insurance, Real Estate	11.0	8.8	8.8
8. Commercial Services	9.3	12.4	11.1

Table 5-12

Manufacturing Industry Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Saskatchewan

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	6.2	6.2	6.2
2. Printing & Publishing	1.6	1.6	1.6
3. Wood Products	1.0	1.6	1.6
4. Paper & Allied Industries	0.7	0.7	0.7
5. Primary Metals	1.1	1.8	1.8
6. Petroleum & Coal Products	0.3	0.6	0.5
7. Clothing	0.4	0.7	1.4
8. Metal Fabricating	0.8	1.1	1.1
9. Machinery	0.9	1.4	1.2
10. Transportation Equipment	0.3	0.4	0.4
11. Electrical Products	0.6	0.6	1.2
12. Chemical Products	0.3	0.3	0.6
13. Residual Manufacturing	0.8	1.1	1.1
Total Manufacturing	15.0	18.1	19.4

Table 5-13

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Alberta

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	7.5	8.8	7.5
3. Manufacturing	16.4	20.0	23.1
4. Construction	6.7	6.7	6.7
5. Transp'n, Comm'n, Utilities	22.6	18.1	18.1
6. Trade	28.0	22.4	22.4
7. Finance, Insurance, Real Estate	6.4	7.6	7.6
8. Commercial Services	11.9	15.9	14.2

Table 5-14

Manufacturing Industry Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Alberta

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	5.2	5.2	5.2
2. Printing & Publishing	0.8	1.3	1.3
3. Wood Products	1.7	1.7	1.7
4. Paper & Allied Industries	0.8	0.8	0.8
5. Primary Metals	0.8	1.3	1.0
6. Non-Metallic Mineral Products	0.9	1.3	1.3
7. Petroleum & Coal Products	0.5	0.7	0.7
8. Clothing	0.7	0.7	1.4
9. Furniture & Fixtures	0.3	0.3	0.3
10. Metal Fabricating	1.2	2.0	1.6
11. Machinery	0.6	0.8	0.8
12. Transportation Equipment	0.7	1.2	2.5
13. Electrical Products	0.5	0.5	1.0
14. Chemical Products	0.8	1.3	2.6
15. Residual Manufacturing	0.9	0.9	0.9
Total Manufacturing	16.4	20.0	23.1

Table 5-15

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, British Columbia

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	2.6	2.6	2.6
2. Mining	2.3	2.4	2.3
3. Manufacturing	23.0	31.2	31.3
4. Construction	3.5	3.5	3.5
5. Transp'n, Comm'n, Utilities	24.9	19.9	19.9
6. Trade	24.0	19.2	19.2
7. Finance, Insurance, Real Estate	9.5	7.6	7.6
8. Commercial Services	10.1	13.5	13.5

Table 5-16

Manufacturing Industry Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, British Columbia

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	3.0	4.0	3.9
2. Printing & Publishing	1.5	1.5	1.5
3. Wood Products	7.1	9.4	9.4
4. Paper & Allied Industries	3.3	5.5	4.4
5. Primary Metals	1.8	2.3	2.3
6. Non-Metallic Mineral Products	0.5	0.9	0.7
7. Petroleum & Coal Products	0.2	0.3	0.2
8. Clothing	0.4	0.5	0.5
9. Furniture & Fixtures	0.2	0.3	0.3
10. Metal Fabricating	1.2	1.7	1.7
11. Machinery	0.6	0.8	0.8
12. Transportation Equipment	1.1	1.5	1.5
13. Electrical Products	0.8	0.8	1.6
14. Chemical Products	0.7	0.7	1.5
15. Residual Manufacturing	0.6	1.0	1.0
Total Manufacturing	23.0	31.2	31.3

Table 5-17

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Manitoba

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	2.5	2.5	2.5
3. Manufacturing	26.4	29.9	30.8
4. Construction	3.2	3.2	3.2
5. Transp'n, Comm'n, Utilities	24.8	23.5	22.9
6. Trade	23.9	22.9	22.9
7. Finance, Insurance, Real Estate	9.1	7.3	7.3
8. Commercial Services	9.6	10.2	9.9

Table 5-18

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Manitoba

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	6.4	6.4	6.4
2. Printing & Publishing	2.4	2.4	2.4
3. Wood Products	0.6	0.8	0.8
4. Paper & Allied Industries	1.5	1.5	1.5
5. Primary Metals	1.0	1.5	1.4
6. Non-Metallic Mineral Products	0.5	0.8	0.6
7. Clothing	4.2	4.2	4.5
8. Furniture & Fixtures	0.6	0.8	0.8
9. Metal Fabricating	1.7	2.2	2.2
10. Machinery	1.6	2.1	2.1
11. Transportation Equipment	2.1	3.4	2.8
12. Electrical Products	1.2	1.2	2.5
13. Chemical Products	0.6	0.6	1.2
14. Residual Manufacturing	2.0	2.0	1.6
Total Manufacturing	26.4	29.9	30.8

Table 5-19

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Saskatchewan

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.7	0.7	0.7
2. Mining	4.8	6.2	5.5
3. Manufacturing	13.7	17.3	18.6
4. Construction	4.2	4.2	4.2
5. Transp'n, Comm'n, Utilities	27.1	24.7	24.7
6. Trade	29.1	26.4	26.4
7. Finance, Insurance, Real Estate	11.0	8.8	8.8
8. Commercial Services	9.3	11.9	11.3

Table 5-20

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Saskatchewan

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	3.7	5.5	5.6
2. Printing & Publishing	1.6	1.6	1.6
3. Wood Products	1.5	1.6	1.6
4. Paper & Allied Industries	0.7	0.7	0.7
5. Primary Metals	1.8	1.8	1.8
6. Petroleum & Coal Products	0.3	0.5	0.5
7. Clothing	0.4	0.6	0.6
8. Metal Fabricating	0.8	1.1	1.1
9. Machinery	0.9	1.5	1.8
10. Transportation Equipment	0.3	0.4	0.4
11. Electrical Products	0.6	0.6	1.2
12. Chemical Products	0.3	0.3	0.6
13. Residual Manufacturing	0.8	1.1	1.1
Total Manufacturing	13.7	17.3	18.6

Table 5-21

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Alberta

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	9.4	10.0	10.0
3. Manufacturing	14.6	18.1	19.6
4. Construction	6.7	7.8	6.7
5. Transp'n, Comm'n, Utilities	22.6	18.1	18.1
6. Trade	24.7	22.4	22.4
7. Finance, Insurance, Real Estate	9.5	7.6	7.6
8. Commercial Services	11.9	15.5	15.2

Table 5-22

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Alberta

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	3.1	4.1	4.2
2. Printing & Publishing	1.3	1.3	1.3
3. Wood Products	1.3	1.4	1.4
4. Paper & Allied Industries	0.8	0.8	0.8
5. Primary Metals	0.8	1.0	1.0
6. Non-Metallic Mineral Products	0.9	1.5	1.3
7. Petroleum & Coal Products	0.5	0.8	0.8
8. Clothing	0.4	0.6	0.6
9. Furniture & Fixtures	0.3	0.3	0.3
10. Metal Fabricating	1.2	1.6	1.6
11. Machinery	0.6	1.0	0.8
12. Transportation Equipment	0.7	1.0	1.0
13. Electrical Products	0.5	0.5	1.0
14. Chemical Products	1.3	1.3	2.6
15. Residual Manufacturing	0.9	0.9	0.9
Total Manufacturing	14.6	18.1	19.6

Table 5-23

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, British Columbia

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	2.6	2.6	2.6
2. Mining	2.3	3.0	3.0
3. Manufacturing	25.2	30.9	31.7
4. Construction	3.5	3.8	3.5
5. Transp'n, Comm'n, Utilities	24.9	19.9	19.9
6. Trade	21.8	19.0	18.0
7. Finance, Insurance, Real Estate	9.5	7.6	7.6
8. Commercial Services	10.1	13.1	13.5

Table 5-24

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, British Columbia

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	3.0	3.9	3.9
2. Printing & Publishing	1.5	1.5	1.5
3. Wood Products	7.1	9.4	9.4
4. Paper & Allied Industries	5.0	5.5	5.5
5. Primary Metals	2.3	2.3	2.0
6. Non-Metallic Mineral Products	0.5	0.9	0.7
7. Petroleum & Coal Products	0.2	0.3	0.3
8. Clothing	0.4	0.5	0.5
9. Furniture & Fixtures	0.2	0.3	0.3
10. Metal Fabricating	1.2	1.7	1.7
11. Machinery	0.6	0.8	0.8
12. Transportation Equipment	1.1	1.5	2.1
13. Electrical Products	0.8	0.8	1.6
14. Chemical Products	0.7	0.7	0.6
15. Residual Manufacturing	0.6	0.8	0.8
Total Manufacturing	25.2	30.9	31.7

Table 5-25

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Manitoba

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	1.9	1.9	1.9
3. Manufacturing	29.0	33.4	39.8
4. Construction	2.4	2.4	2.4
5. Transp'n, Comm'n, Utilities	24.6	23.2	19.3
6. Trade	23.1	22.9	21.2
7. Finance, Insurance, Real Estate	11.4	7.3	7.3
8. Commercial Services	7.2	8.5	7.4

Table 5-26

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Manitoba

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	7.9	7.9	7.9
2. Printing & Publishing	3.0	3.0	3.0
3. Wood Products	0.5	0.8	0.8
4. Paper & Allied Industries	1.8	1.8	1.8
5. Primary Metals	0.8	1.5	1.4
6. Non-Metallic Mineral Products	0.3	0.8	0.6
7. Clothing	5.3	4.7	5.5
8. Furniture & Fixtures	0.5	0.8	0.8
9. Metal Fabricating	1.2	2.2	2.2
10. Machinery	1.2	2.1	2.1
11. Transportation Equipment	1.6	3.4	2.8
12. Electrical Products	1.6	1.6	6.2
13. Chemical Products	0.8	0.8	3.1
14. Residual Manufacturing	2.5	2.0	1.6
Total Manufacturing	29.0	33.4	39.8

Table 5-27

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Saskatchewan

Sector	Scenario One	Scenario Two	Scenario Three
	(Per cent)		
1. Forestry	0.7	0.7	0.7
2. Mining	3.6	5.8	4.1
3. Manufacturing	12.3	19.1	23.1
4. Construction	3.1	3.1	3.1
5. Transp'n, Comm'n, Utilities	29.0	24.7	24.7
6. Trade	30.6	26.4	26.4
7. Finance, Insurance, Real Estate	13.7	8.8	8.8
8. Commercial Services	7.0	11.5	9.3

Table 5-28

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Saskatchewan

Industry	Scenario One	Scenario Two	Scenario Three
	(Per cent)		
1. Food & Beverages	2.8	5.6	5.6
2. Printing & Publishing	2.0	2.0	2.0
3. Wood Products	1.1	2.0	2.0
4. Paper & Allied Industries	0.9	0.9	0.9
5. Primary Metals	1.7	2.3	2.3
6. Petroleum & Coal Products	0.3	0.5	0.5
7. Clothing	0.3	0.6	0.8
8. Metal Fabricating	0.6	1.1	1.1
9. Machinery	0.7	1.5	1.8
10. Transportation Equipment	0.2	0.4	0.4
11. Electrical Products	0.7	0.7	3.0
12. Chemical Products	0.4	0.4	1.6
13. Residual Manufacturing	0.6	1.1	1.1
Total Manufacturing	12.3	19.1	23.1

Table 5-29

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Alberta

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	0.5	0.5	0.5
2. Mining	7.8	10.0	8.8
3. Manufacturing	13.0	20.0	25.5
4. Construction	5.0	6.4	5.0
5. Transp'n, Comm'n, Utilities	28.2	18.1	16.0
6. Trade	24.8	22.4	21.4
7. Finance, Insurance, Real Estate	11.9	7.6	7.6
8. Commercial Services	9.0	14.9	15.2

Table 5-30

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, Alberta

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	2.3	4.1	4.2
2. Printing & Publishing	1.6	1.6	1.6
3. Wood Products	1.0	1.4	1.4
4. Paper & Allied Industries	1.0	1.0	1.0
5. Primary Metals	0.6	1.0	1.0
6. Non-Metallic Mineral Products	0.7	1.8	1.3
7. Petroleum & Coal Products	0.4	1.0	0.8
8. Clothing	0.3	0.6	0.6
9. Furniture & Fixtures	0.2	0.3	0.3
10. Metal Fabricating	0.9	1.6	1.6
11. Machinery	0.5	1.3	0.8
12. Transportation Equipment	0.6	1.0	1.0
13. Electrical Products	0.6	0.6	2.5
14. Chemical Products	1.6	1.6	6.5
15. Residual Manufacturing	0.7	1.1	0.9
Total Manufacturing	13.0	20.0	25.5

Table 5-31

Sectoral Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, British Columbia

Sector	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Forestry	2.0	2.0	2.0
2. Mining	1.7	3.0	3.0
3. Manufacturing	20.9	33.3	34.2
4. Construction	2.6	2.8	2.6
5. Transp'n, Comm'n, Utilities	31.1	19.9	19.9
6. Trade	21.9	18.4	17.2
7. Finance, Insurance, Real Estate	11.9	7.6	7.6
8. Commercial Services	7.6	13.0	13.5

Table 5-32

Manufacturing Industry Employment Weights after Fully Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Dynamic Case, British Columbia

Industry	Scenario One	Scenario Two	Scenario Three
		(Per cent)	
1. Food & Beverages	2.2	3.9	3.9
2. Printing & Publishing	1.9	1.9	1.9
3. Wood Products	5.3	9.4	9.4
4. Paper & Allied Industries	3.7	6.5	6.7
5. Primary Metals	2.4	2.8	2.0
6. Non-Metallic Mineral Products	0.4	0.9	0.7
7. Petroleum & Coal Products	0.1	0.4	0.4
8. Clothing	0.3	0.5	0.5
9. Furniture & Fixtures	0.1	0.3	0.3
10. Metal Fabricating	0.9	1.7	1.7
11. Machinery	0.5	0.8	0.8
12. Transportation Equipment	0.8	1.5	2.1
13. Electrical Products	1.0	1.0	2.4
14. Chemical Products	0.9	0.9	0.6
15. Residual Manufacturing	0.4	0.8	0.8
Total Manufacturing	20.9	33.3	34.2

Table 5-33

Binding Position, Yes or No, of Employment Growth and Employment Earnings Constraints, Three Scenarios, Static and Dynamic, Manitoba

Rules/Scenario	Employment Growth			Employment Earnings		
	One	Two	Three	One	Two	Three
Static	N	Y	Y	Y	Y	Y
Dynamic Two	N	Y	Y	Y	Y	Y
Dynamic Three	N	Y	Y	Y	Y	Y

Table 5-34

Binding Position, Yes or No, of Employment Growth and Employment Earnings Constraints, Three Scenarios, Static and Dynamic, Saskatchewan

Rules/Scenario	Employment Growth			Employment Earnings		
	One	Two	Three	One	Two	Three
Static	Y	Y	Y	Y	Y	Y
Dynamic Two	N	Y	Y	Y	Y	N
Dynamic Three	N	Y	N	Y	Y	N

Table 5-35

Binding Position, Yes or No, of Employment Growth and Employment Earnings Constraints, Three Scenarios, Static and Dynamic, Alberta

Rules/Scenario	Employment Growth			Employment Earnings		
	One	Two	Three	One	Two	Three
Static	Y	Y	Y	Y	Y	Y
Dynamic Two	Y	Y	Y	Y	Y	Y
Dynamic Three	Y	Y	Y	Y	Y	N

Table 5-36

Binding Position, Yes or No, of Employment Growth and Employment Earnings Constraints, Three Scenarios, Static and Dynamic, British Columbia

Rules/Scenario	Employment Growth			Employment Earnings		
	One	Two	Three	One	Two	Three
Static	N	Y	Y	Y	Y	Y
Dynamic Two	N	Y	Y	Y	Y	Y
Dynamic Three	N	Y	Y	N	Y	Y

Table 5-37

Measures of Provincial Employment Instability Before and After Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Static and Dynamic, Manitoba

Rules of Game	Scenario One	Scenario Two	Scenario Three
Status Quo	.0337	.0337	.0337
Partial Constraints	.0309	.0323	.0308
Full Constraints	.0313	.0324	.0317
Iteration Two	.0292	.0312	.0292
Iteration Three	.0273	.0301	.0262

Table 5-38

Measures of Provincial Employment Instability Before and After Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Static and Dynamic, Saskatchewan

Rules of Game	Scenario One	Scenario Two	Scenario Three
Status Quo	.0409	.0409	.0409
Partial Constraints	.0369	.0386	.0376
Full Constraints	.0373	.0390	.0379
Iteration Two	.0342	.0374	.0337
Iteration Three	.0318	.0359	.0289

Table 5-39

Measures of Provincial Employment Instability Before and After Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Static and Dynamic, Alberta

Rules of Game	Scenario One	Scenario Two	Scenario Three
Status Quo	.0541	.0541	.0541
Partial Constraints	.0490	.0518	.0508
Full Constraints	.0505	.0534	.0522
Iteration Two	.0474	.0526	.0504
Iteration Three	.0449	.0517	.0485

Table 5-40

Measures of Provincial Employment Instability Before and After Constrained Optimization to Minimize Provincial Employment Instability, Three Scenarios, Static and Dynamic, British Columbia

Rules of Game	Scenario One	Scenario Two	Scenario Three
Status Quo	.0416	.0416	.0416
Partial Constraints	.0376	.0404	.0397
Full Constraints	.0379	.0406	.0404
Iteration Two	.0345	.0398	.0395
Iteration Three	.0316	.0391	.0387

Chapter 6: CONCLUSION

This concluding chapter is concerned with two major themes that have been essentially overlooked in the study to this point. First we develop the principal industrial policy implications. These implications have so far been merely "hinted at" rather than developed. We did this to permit the reader to work out her/his own implications after assimilating the material in the previous chapters; it seems best to present the basic material unencumbered by prior policy viewpoints. The first major theme of this chapter, therefore, should be regarded as one possible "guided tour" of policy implications. The reader, of course, should feel free to develop alternative implications or to even conclude that the study has no such implications. The second major theme concerns suggestions for further research. Here we spell out, again on the basis of previous "hints", the main limitations of our statistical data base. These limitations, however, should not be understood to mean that the present study is merely a prelude to possible future research. Indeed, the first theme of the chapter tries to make clear that the study's data base already has substantial value in terms of policy lessons. It is, nevertheless, true that our data base has serious shortcomings and we then make a series of concrete recommendations upon which these shortcomings can be removed. Some of these recommendations have already been (partly) put into effect as will be seen by some experimental tabular results.

Needless to say, the two major themes of this chapter are ultimately related and are best considered together rather than separately. One other theme that "lurks" throughout this chapter concerns the rather narrow and specialized treatment of the Western provinces that we have thus far developed. The development has indeed been "intensive" rather than "extensive". In reality we need both. We think it is possible to link more extensive knowledge of a province's economic structure, institutions and economic traditions to the intensive treatment of industrial diversification found here. But this must be done in the context of a province's economic decision-making apparatus rather than a "working manual" of this nature.

Implications for Industrial Policy

This study is faced with the perennial dilemma of all empirical research. Our empirical results are based, by necessity, on historical data (actually 1970-83), yet the important policy problems are all future-directed. Indeed one might say that an industrial policy perspective should be quite long term in the future. How can this dilemma be resolved? The reader should note that the dilemma exists because of our implicit insistence on a reasonably empirical framework and our desire to avoid sheer speculation. It will be argued, therefore, that though our empirical framework is suggestive for policy purposes, its main function is educational -- to stimulate policy thinking in new directions. We also try to provide concrete tools for policy makers whose orientations are more specific than ours.

This section is written in terms of possible answers, based on the empirical research, to a number of industrial policy-oriented questions. The prime context, of course, is the four provinces of Western Canada. First, do the Western provinces experience a serious economic instability problem? The answer to this question, like all other economic questions, evidently depends on the time, method and coverage of the associated measures of economic instability. This study concentrates on employment instability, based on 1970-83 monthly observations, and effectively covering the incorporated non-agricultural business sectors of the provincial economies. In this particular context it is found that the Western provinces (especially Alberta) are more unstable compared to the Central Canada provinces (especially Ontario). If the agriculture sector employment is included, then the Western provinces are even more unstable compared to the Central provinces; Saskatchewan then becomes the most unstable province. Our main analysis, however, excludes agriculture.[1] It is also important to note the exclusion of public administration and small-firm services from our measurements. Alternatively, economic instability could be measured on the basis of annual observations and with reference to provincial income rather employment. We chose employment because the portfolio approach can optimally reallocate employment to minimize instability (subject to constraints), a procedure that cannot be directly applied to income. The constraints of our portfolio approach do, however, indirectly account for employment income.

The main lesson, then, is that we do not possess a "universal" answer to the first policy-oriented question. Rather we claim to have identified a substantial portion of the Western provincial economies that do experience considerable (employment) instability, at least relative to the Central provinces. This claim is made on the basis of the most recent long-term set of (monthly) data available. One might conclude that Western Canada provincial "complaints" about their economic instability problem are reasonably justified within the identification scope of our analysis, but may not be justified within a different framework.[2]

A second policy-oriented question is as follows. Are the Western provinces more "diversified" or less "diversified" compared to the Central provinces? This may seem to be a very natural question in our context. It turns out, however, that the question per se is not well-directed. If we were to adopt a traditional view of "diversification" (the number and relative importance of "different" industries in which a province's employment is active),[3] one might be tempted to conclude that the Central provinces are less diversified than the Western provinces since the former have a highly skewed concentration of manufacturing employment (compare the sectoral distribution employment weights in Tables 3-11 to 3-16 of Chapter 3). We prefer, however, to adopt the portfolio view of diversification in which industries differ, not because they have different official names, but because their respective employment fluctuation behaviours are effectively different and, therefore, countervailing. Under these conditions the measure of a province's employment instability is more liable to reflect the degree of effective diversification enjoyed by the province's industrial distribution of employment.[4] So in our view, and judging from the given data base, it would seem that the Central provinces are more diversified than the Western provinces. In any event, all this is a "non-issue". What really matters is the measure of provincial instability and the fact that a province can reduce such instability by moving in the direction of greater industrial diversification along the lines of our optimal portfolio analysis.

This leads to a third question. Can the measure of employment instability for each Western province be reduced significantly by employment redistribution among each of the respective provinces' industries? This is the subject of Chapter 5 (Tables 5-37 to 5-40). There it is found that considerable reduction of provincial employment instabilty is possible, particularly under scenario nos. one and three. Minimization of employment instabilty should be fully restrained so that two major economic conditions (provincial employment growth and provincial average earnings) are not violated. Even under the restraints, considerable gains in terms of employment stability are possible, but the gains only become significant[5] in the very long term (requiring multi-iteration dynamic scenarios). We find that all four Western provinces are capable of similar proportional reductions in employment instability after one iteration (reductions ranging between 7 per cent and 9 per cent). Big differences in "performance" do occur, however, after three iterations. Saskatchewan is capable of reducing its employment instability by almost 30 per cent; the corresponding figures for British Columbia, Manitoba and Alberta are 24 per cent, 22 per cent and 17 per cent respectively. This question will be taken up again in the next section where various extensions are explored to increase the number of options open to manipulation. The additional options all raise the efficacy of optimal portfolio analysis and related employment redistribution towards reducing provincial employment instability.

Based on present estimates we now ask the following. What are some concrete examples of stability-promoting industries in the Western provinces? Are these stability-promoting "winners" the same in all provinces or do they differ? What specifically characterizes such "winners" (in contrast to instability-promoting "losers")? We will not give detailed answers to these questions since the details are already available in the many tables of Chapter 5. Briefly it has been found that under the neutral scenario one, the sector referred to as FIRE (finance & insurance & real estate) is always a clear "winner" in terms of relative gain in employment after optimal diversification. Two other non-manufacturing sectors are often (not always for all provinces) winners, namely TCU (transportation & communication & utilities) and trade, but the case for TCU is generally stronger. The manufacturing sector as a whole is only a "winner" under scenario one in Manitoba. But within manufacturing we find that printing & publishing, electrical products and chemical products are all "winners" in each and every province (even under a strictly neutral scenario). Sectors and individual manufacturing industries that clearly promote provincial employment stability appear to have most (not, necessarily all) of the following properties: (1) a relatively low measure of own-employment instability, (2) either a relatively high growth rate of long-term employment or at least a moderate level of average earnings or both, and (3) employment fluctuations around trend with correlation coefficients close to zero measured relative to employment fluctuations of other important[6] sectors or industries in the same province. Property (3) represents effective diversification. It should be noted that some "winners" in some provinces clearly possess all the preceding properties. On the other hand, some "winners" utterly fail with respect to one of the characteristic properties and there is no way of telling whether the "winner" will really emerge unless the quadratic programming algorithm is carried out. Take, for example, the Saskatchewan electrical products manufacturing industry. The own-employment instability measure for this industry equals 0.230, the highest in the province (see Tables 3-14 and 3-23). Yet the industry is a clear "winner" mainly due to its outstanding diversification properties -- negative correlations with almost all other manufacturing industries and important non-manufacturing sectors such as TCU and trade (see Table 4-13). There are, then, some complex "trade-offs" between the various properties. Also, because of this study's particular concern for manufacturing, we add some additional remarks. Manitoba's clothing industry is a clear "winner" even under scenario one, although the industry's average wage level is the lowest in the province. Clothing, however, does not gain from employment redistribution in any other Western province. Food & beverages is also a "winner" in Manitoba but nowhere else. Paper & allied industries make marginal gains in employment in the three Prairie provinces, but certainly not in British Columbia where this important industry (important in terms of its initial employment weight) is a clear "loser". Finally, all remarks relevant to manufacturing in the neutral scenario one carry over mutatis mutandis to the other scenarios where manufacturing is explicitly favoured.

This naturally leads to the next question. Can the various Western provinces attain greater employment stability by "pushing" their secondary manufacturing sectors? This question has already been implicitly answered in Chapter 5. Comparing the results of scenario one with corresponding results of scenario three (which strongly favours secondary manufacturing)[7] we find that the situation differs from province to province. For Manitoba and Saskatchewan the secondary manufacturing "route" is both possible and desirable in terms of potentially lowering provincial levels of employment instability. However, as we already noted in response to a previous question, the major payoff from reduction of instability does not occur until the third iteration (a very long-term proposition at best). This point will be discussed again later in the chapter. For Alberta and British Columbia the secondary manufacturing "route" is agan possible since there do exist some individual secondary industries in both provinces which have the required properties of being stability-promoting winners. The best examples would be electrical products and chemcial products in Alberta and printing & publishing[8] and electrical products in British Columbia. If these industries are pushed far enough (iteration three) then provincial employment instability would decline. But this "route" is no longer desirable since the ultimate payoff in terms of reduction in employment instability is small relative to the (more) "neutral" scenario one.

What does our diversification analysis reveal with respect to "further processing" of natural resources? In particular, do the primary manufacturing industries of Western Canada represent effective diversification compared to their corresponding natural resource sectors? We can only partly answer these questions because our level of industrial disaggregation is not sufficiently fine for a complete analysis.[9] In Chapter 4 it was shown that the correlation coefficient between two industries' (or sectors') respective employment fluctuations around trend is the key indicator of effective economic diversification. When the coefficient is relatively large (and close to unity), the two industries' employment experiences are reinforcing so that changes in employment distribution between the two industries, even if feasible, would have little effect on provincial employment instability. Let us examine the situation in some cases. First, in British Columbia, the particular correlation coefficient between the forestry natural resource sector and the wood products (primary) manufacturing industry equals 0.76 (the highest correlation coefficient registered by both the given sector and industry; see Table 4-15). There would then be only a very small potential reduction in employment instability as a result of changes in employment mix towards, say, more "primary processing" of British Columbia's forestry resources. Second, again in British Columbia, the correlation coefficient between the forestry sector and the paper & allied manufacturing industry equals 0.54 (the second highest coefficient registered by forestry and the highest for paper & allied industry). So, more "further processing" of the province's forestry resources does represent a marginal gain in terms of diversification and potential reduction of instability. The gain, though, would be small. Turning to Alberta, the correlation coefficient between the mining natural resource sector (dominated by employment in oil and gas wells)[10] and the petroleum & coal products (primary) manufacturing industry equals 0.72 (see Table 4-14) which is "too" high for effective diversification. Other correlation coefficients could also be indicated, but the results would be difficult to interpret because of the output heterogeneity of the associated aggregations.[11]

How can the portfolio version of diversification, emphasized in this study, be related to the other meaning of diversification concerned with long-term future growth prospects of provincial industries?[12] Long-term growth already enters our optimal portfolio calculations, but only on the basis of historical (1970-83) observations. Also we do not attempt to change employment distribution in order to maximize provincial long-term (historical) growth; the latter, rather, is a constraint on minimizing provincial employment instability. There is, however, a possibility of linking the two principal meanings of diversification. First it should be noted that the provincial long-term (historical) employment growth constraint enters our calculations in a linear homogeneous form. This, in effect, means that provincial employment growth is always equal to a simple employment weighted average of the employment growth rates of the provincial sectors and industries. If all employment growth rates, both aggregate and disaggregated, were changed in the same proportion the identity and corresponding constraint would continue to hold. Take, for example, the case of Alberta. Our calculations use the observed provincial employment growth rate of 5.9 per cent (Table 3-1) and all the corresponding disaggregated employment growth rates from Alberta's Tables 3-9 and 3-20. One might argue that these employment growth figures are unrealistically high for future applications. However, all our results, including calculated reductions in Alberta employment instability following optimal redistribution of employment, continue to hold if a new set of long-term employment growth rates is chosen as the economic goal constraint with the new set all proportionally lower (to any extent)[13] compared to the original set used in the constraint.

If, on the other hand, we move to the future direction of non-proportional changes in observed employment growth rates, then our calculated results would not hold. Taking again, Alberta, it might be argued that the observed employment growth rates for the mining sector (8.9 per cent) and petroleum & coal products manufacturing (10.6 per cent) should be reduced proportionally more than all other sector and industry employment growth rates for future-relevant application.

We have not experimented with the possible impact of such non-proportional changes in the employment growth constraint since for our calculations it is necessary to be precise. In theory, of course, it is perfectly possible to choose any set of future-projected employment growth rates and use these as a constraint in the optimal portfolio program.[14] In this sense, then, the two meanings of diversification can be linked. We know, from the characteristics of our program, that particular sectors or industries with greater non-proportional decreases in employment growth than others (in the new constraining relationship) are less likely to emerge as stability-promoting "winners" because the provincial-level employment constraint is more liable to violation if these sectors or industries are promoted. All this, however, is only one characteristic of our program; all other characteristics would remain unchanged. Briefly, then, we should not expect major changes in our most important results even if the two meanings of diversification are formally linked. Finally it should also be noted that the "problem" entirely disappears when the new future-directed employment growth constraint (with non-proportionality properties) turns out to be ineffective (i.e., non-binding). In fact we have already experimented with such non-binding constraints to observe the impact on original results where the historical employment growth constraint was actually binding.[15] Our simulations indeed show that the major results (identification of stability-promoting "winners") are largely invariant to the presence or absence of the observed employment growth constraint.

We could now continue with the next question. In the optimal portfolio exercises, employment (re)distribution is the variable subject to (marginal) manipulation so as to minimize provincial employment instability. The redistribution occurs in an overall growth context so that we do not necessarily assume that the employed labour force of a province is fixed in any way. In fact, as pointed out in the preceding paragraphs, the provincial employment growth level can take on any (positive) value so long as all disaggregated employment growth rates are proportionally adjusted. A question arises, however, with regard to the (observed) individual employment growth rates for provincial sectors and manufacturing industries. These growth rates are not all equal; differential rates of employment growth will themselves alter employment distribution among each province's sectors and industries.[16] (The impact on employment distribution would depend not only on the pattern of differentials, but also on their overall levels.) How, then, can the results of our optimal diversification analysis be interpreted in the presence of (observed) differential rates of employment growth? First it should be noted that when provincial employment growth is introduced as a constraint in our analysis this *per se* works in the direction of removing a possible inconsistency since particular sectors or industries with relatively high employment growth rates are more likely to become stability-promoting "winners" and, therefore, candidates for a greater share of provincial employment. This latter relationship, of course, holds true *ceteris paribus* and is most likely to occur when the provincial employment growth constraint in binding. But, as mentioned earlier, there are other forces at work which do not guarantee that observed employment growth and optimal employment redistribution will both work in the same direction.[17] It seems best to interpret the results as follows. Optimal redistribution of employment should be regarded as a potential policy operation to be performed during an *initial* long-term period so as to minimize provincial employment instability, subject to the same period's provincial employment earnings constraint and the scenario's boundary limitations (based on the historical employment distribution). The details of the policy operation would depend on the extent to which the optimal redistribution of employment and differential employment growth rates (of the initial period) do or do not coincide.[18] We also formally maintain the provincial employment growth constraint -- again to avoid undue stability-promotion of sectors or industries with poor long-term growth prospects. But this constraint should be regarded as referring to the *next* long-term time period rather than the initial long-term time period (even though the growth patterns inherent in the constraint may be based on initial period "observations"). In this way, therefore, we can remove, at least conceptually, the "feedback" problem of employment growth on employment redistribution. There are also more advanced (technical) methods for handling such problems and these are outlined in Appendix A. Finally, the above suggested interpretation of our results also applies mutatis mutandis to the dynamic (multi-iteration) scenarios of the previous chapter.

What other methods are there (i.e., other than employment redistribution in a growth context) for reducing provincial employment instability? And how can these methods be related to the context of this study? One method is by provincial and federal policies to decrease the amplitude of business cycle forces and other medium-term fluctuations around long-term trends.[19] If the impact of such policies is reasonably uniform across a province's sectors and industries, then overall employment instability will certainly be reduced, but our specific results concerning stability-promoting "winners" and instability-promoting "losers" will continue to hold (and will lead to even further reductions in provincial employment instability). Another method is to increase intra-provincial labour mobility and the availability of labour market information. These measures will cut down on the existence of frictional unemployment, frictional vacancies and related aspects of labour market search behaviour. Labour market policies then tend to mitigate the consequences of provincial employment instability -- outlined earlier in the first section of Chapter 5.

But such policies do not per se reduce provincial employment instability except, perhaps, marginally. There is, no doubt, that all three policies (including employment redistribution) can be effective and are certainly not contradictory. One other method is to attempt to restructure the economic forces that give rise to strong positive correlations between different sectors' (or industries') employment fluctuations around trend. We know that such positive correlations, between important aspects of the provincial economy, result in relatively high measures of employment instability and make economic diversification difficult to obtain.[20] The correlation coefficient matrices exhibited in Chapter 4, and their corresponding scaled covariance matrices, reflect basic provincial economic structure such as industrial interdependence (intermediate demand) and commodity consumption complementarities (final demand).[21] In our view, such paramatric structure is difficult to change and best regarded as a provincial economic fact of life, at least as a first approximation. There is, however, an important point so far overlooked. All the correlation coefficients and, indeed, all our measures of own- and cross-employment instability also reflect the industrial disaggregation level. Just as provincial employment instability can be altered by intra-provincial employment redistribution (subject to constraints), so could any of the individual industry employment instabilities be altered (own-wise and cross-wise) by intra-industry employment redistribution. This, of course, requires a finer level of industrial disaggregation and, represents, in our view the best approach for "changing" provincial economic structure. This approach will be further considered in the next section.

What specific policy operations are required for shifting intra-provincial employment distribution in an employment growth context so as to reduce provincial employment instability? This key question is best answered after discussing some related aspects of further research suggestions, to which we now turn.

Suggestions for Further Research

Some suggestions for further research have already been implied throughout the study. Here the suggestions are spelled out more explicitly, but the exposition is kept brief. Also, some of the suggestions tend to be technical and reference must be made to Appendix A.

First it should be recalled that the optimal diversification exercise is performed on the basis of a given observed industrial classification. This permits an empirical analysis and is consistent with a province's (or sub-provincial area's) supposed goal to (relatively) expand or contract employment in existing industries in order to reduce employment instability. The framework, however, is not consistent with a province's goal to attract employment in entirely new industries -- for which data observations are not yet available. In this important case it might be possible to conjecture the missing data. We will need the new industry's: (1) long-term (expected) employment growth rate, (2) average employment earnings, (3) a measure of own-industry employment instability, and (4) all cross-industry employment instabilities involving the new industry.[22] The last requirement is the most difficult and really involves simulating the expected time pattern of employment fluctuations around trend experienced by the new industry and then correlating with all other (existing) industries. The task is not impossible and, indeed, can be accomplished on the basis of a well-known simplified model of portfolio analysis.[23] There is, however, one special case where the "solution" to the problem is actually trivial; this is the case where the new industry is expected to exhibit a perfectly stable employment behaviour (i.e., employment "fluctuations" coincide with the long-term non-linear employment growth trend). Then the measure of own-industry employment instability equals zero and so do all cross-employment instability measures involving the new industry. We have in fact introduced such a fictitious industry into one of the optimal diversification exercises run in the previous chapter. Scenario two was modified to include this additional industry; the latter was subject to a boundary limitation equal to 2.5 per cent of the provinces' employed labour force.[24] The modified scenario two was run on the basis of partial constraints (since full constraints would require knowledge of the fictitious industry's long-term employment growth rate and average employment earnings). The usual sets of results are shown in Tables 6-1 to 6-4 and may be compared with analogous results (without the new industry) in Tables 5-9 to 5-16, scenario two columns. For all Western provinces the new sets of tables show that employment redistribution results in maximum permissible employment (2.5 per cent of labour force) in the new industry. Previous results regarding stability-promoting "winners" are essentially preserved,[25] but the big "winner" is now the new industry itself. In Table 6-5 we compare measures of provincial employment instability before optimization (status quo) and after optimization (modified scenario two). The presence of the fictitious industry, then, permits further gains in terms of reduction in provincial employment instability. Note, however, that the perfect stability property of the new industry is not necessarily "ideal"; a new industry with considerable own-employment instability might better promote effective diversification and, therefore, provincial stability if the new industry's employment fluctuations around trend were strongly negatively correlated with those of other important sectors and industries in the same province.

An important topic, implicitly referred to in the study, is the subject of industrial disaggregation. Again, all results of the optimal portfolio analysis reflect the given (and existing) sectoral and industrial classification. It is relevant, therefore, to consider the sensitivity of our main results to the choice of industrial disaggregation level. Briefly it can be shown, both theoretically and empirically, that optimal portfolio analysis is sensitive to disaggregation. In our context, an individual province can do no worse and can often do significantly better, in terms of employment stability, by performing the optimal diversification exercise at a finer level of industrial disaggregation. The reason for this can be seen intuitively. Finer disaggregation permits more discrimination; if two industries with different employment behaviours are simply aggregated, then their aggregation must be treated alike even though the "parts" are different. In the aggregate, employment in the two parts must either expand proportionally or contract proportionally, according to the results of the optimal portfolio analysis.[26] On the other hand, when the two parts are distinguished (as they are in disaggregation), no such proportionality restrictions are required and there are, then, more degrees of freedom to the analysis. In terms of provincial employment instability, we should expect greater reductions when disaggregation is carried out for those industrial aggregates composed of individual industries with the most distinct employment experiences. This raises the potential for more effective industrial diversification. It might also be noted that the measures of own-employment instability for disggregates may all turn out to be greater than the corresponding measure for the aggregate industry -- but this is not a new phenomenon. To illustrate the importance of disaggregation we have performed scenario one (the "neutral" scenario) at two different levels of disaggregation. In the first level, the manufacturing sector is not disaggregated and so the analysis consists of the eight basic industrial sectors. In the second level, manufacturing is disaggregated and so the analysis is identical to that reported in Chapter 5. For both levels, the rules of the game are scenario one and only the provincial long-term employment growth constraint is imposed. The resulting measures of provincial employment instability are shown, for the two disaggregation levels, in Table 6-6. Clearly, the finer level of disaggregation always leads to greater reduction in employment instability as a result of optimal diversification. Manitoba, in this case, benefits proportionally the most from manufacturing disaggregation; Alberta benefits the least. It should be noted, though, that the issue of which Western province benefits the most or benefits the least depends on the particular scenario and also on the particular industrial sector that is disaggregated. In any event, no province can do worse from greater industrial disaggregation and, therefore, greater discrimination in optimal portfolio analysis.

It now seems natural to ask: how far should disaggregation be carried in an optimal diversification exercise? It is true that finer disaggregation adds to programming complexity and statistical data requirements, not to mention issues of data confidentiality and "explanation" of results. When very small industries are disaggregated ("small" in terms of employment weight) the impact on final results would also be small, at least in the static scenarios. When moving to dynamic (multi-iteration) scenarios, the case for finer disaggregation is stronger. This is probably the best way to expose the stability-promoting potential of existing small industries. We do not recommend any "hard and fast" rules concerning disaggregation other than the following. All industrial sectors of our analysis, except forestry and, perhaps, construction, should be further disaggregated along the lines of the manufacturing sector disaggregation. Within the manufacturing sector, the food & beverages manufacturing industry and residual manufacturing industry should be further disaggregated in all provinces. These considerations lead to two further points. If a province or sub-provincial area is seriously interested in reducing employment instability (subject to the recommended economic goal constraints), then the optimal portfolio analysis is best performed in an industrial context with universal (or close to universal) employment coverage.[27] Second, even if the optimal diversification exercise is limited to certain industrial sectors (e.g., manufacturing), it is still essential for the analysis to retain the provincial economy-wide context. Changing the portfolio composition (i.e., employment distribution) within manufacturing alone must also reflect the differential employment fluctuation patterns of individual manufacturing industries vis-à-vis the employment behaviours of the non-manufacturing aspects of the same provincial economy. We have, in fact, performed simulations illustrating the importance of this phenomenon in all Western provinces.

Another suggestion for further research concerns the choice of economic goal constraints to be used in the optimal portfolio analysis. Our choice of the two major constraints (provincial long-term employment growth and provincial average wage and salary levels) was discussed at length in the first section of Chapter 5. Both constraints are linear homogeneous with respect to provincial industry employment weights and, therefore, the results of optimal portfolio analysis are invariant to simple proportionality transformation of the constraints (this was discussed with respect to provincial long-term employment growth in the first section of this chapter, but also applies to the other constraint). The "trick" required for successfully introducing such constraints into the analysis is the simple linear dependence on employment weights -- which are the variables open to (marginal) manipulation in the constrained minimization operation. It is certainly possible to choose other economic goal constraints, satisfying the required property, so long as the provincial industry data are available. The reader will note that all our data is with reference to employment and employment income. Indeed these data exhaust our statistical sources (see Chapter 2). We have not, for example, worked in any measures of industry output. If data were available for value-added on a provincial industry basis,[28] then an alternative constraint can be formulated, with the necessary property, analogous to the provincial average employment earnings constraint already used. The alternative constraint would be created from the identity that provincial aggregate value-added per labour employed equals an employment weighted average of all disaggregated industrial value-added per labour employed in the same province. Observations, if available, could be averaged over the time period of the optimal portfolio analysis, say 1970-83. Value-added is probably a better conceptual constraint than employment income (wage and salary earnings), since value-added is more comprehensive, including the "returns" to physical capital and entrepreneurship as well as labour employed. Indeed, it is even possible, without contradictions, to use all three constraints, recalling that the constraints are formulated as inequalities rather than equalities. In this case, though, only two of the constraints are likely to be binding. Further related discussion appears in Appendix A.

With this background we are now prepared to face a key policy-oriented question posed at the end of the preceding section. To repeat: what specific policy operations are required to shift intra-provincial employment distribution (the initial employment weights) in an overall employment growth context so as to reduce provincial employment instability? To tackle this question, we must make some simplifying assumptions. First, we assume that provincial employment growth is sufficiently strong so that instability-promoting "losers" are not required to absolutely contract in terms of employment -- i.e., not required by public policy (though contraction may occur naturally through market forces). This assumption permits us to focus on stability-promoting "winners" which, therefore, must expand employment both absolutely and relatively (i.e., more than "average"). Now it may happen that stability-promotion coincides with relatively high employment growth through market forces, particularly since the optimal portfolio analysis is subject to a provincial employment growth constraint. This possibility, together with suggested interpretation, was already discussed in the preceding section and shown to be of minor importance.[29] It may also happen that those industries expanding the most in terms of output, do not correspondingly raise employment the most,[30] because of higher-than-average productivity growth. In this case industry wage and salary levels are likely to be relatively high so that the existence of the other provincial economic goal constraint helps to maintain a coincidence between stability-promotion and relatively high employment growth on an industry basis. This possibility is also of minor importance. It would appear, then, that we cannot count on market forces to promote provincial employment stability, at least on the basis of empirical evidence. Indeed, the empirical evidence agrees with what is expected on theoretical grounds.

From the viewpoint of the individual private business decision-maker, there is little (if any) concrete internal economic gain to be obtained from the promotion of external provincial employment stability. The benefits of such stability are primarily social rather than private even under conditions of full information. These benefits were described (but not quantified) in the first section of Chapter 5. The individual firm, that is in a potential stability-promoting position, may directly capture some of the benefits, although most of the benefits accrue indirectly and externally. Even then the individual firm may not be aware of its potential internal gains -- a serious problem of limited information. All this, then, implies that the market does not usually provide explicit incentives for relative employment expansion of individual stability-promoting "winners". So the existence of provincial-wide social gains from optimal industrial diversification leads to the familiar problem of pecuniary externalities. We cannot count on purely *laissez-faire* location and expansion decisions to lead to desirable provincial-wide results. Hence the case for a rational allocation of diversification subsidies. The extent of subsidization should, however, depend upon a quantification of the economic (social) gains to be derived from optimal diversification and, therefore, reduced provincial employment instability.

In this study we do not provide such a quantification which is essentially part of a formal cost-benefit analysis.[31] We do, of course, provide the most important ingredients of a fully quantified analysis, namely: (1) reductions in provincial employment instability that could be expected from optimal portfolio (employment) composition, and (2) identification of stability-promoting "winners" and, therefore, candidates for subsidization. Our view is that even this limited quantified analysis represents significant progress.[32] Nevertheless it is still possible to briefly outline some of the other considerations that must enter a fully quantified analysis. To focus the argument we will make one other simplifying assumption. Each province (or sub-provincial area) is only concerned with scenarios that favour manufacturing (scenarios two and three of Chapter 5) and all existing manufacturing industries ultimately operate under conditions of increasing costs of production. So stability-promoting "winners" must be manufacturing firms and subsidies can be expected to increase output and, therefore, employment.

The question now arises as to the extent of subsidization required to increase employment in stability-promoting manufacturing industries. It should be noted that subsidization could be direct or indirect and could merely involve provision of information. We assume that the necessary provincial government machinery is in place to conduct various forms of subsidy operations.[33] We are, however, concerned with the statistical requirements of the operations. It should again be noted that subsidies are, in effect, acting against free market forces. If individual manufacturing industries already possess comparative advantage and perceived market growth opportunities, then subsidization would not normally be called for. So the extent of subsidization would usually depend upon how far existing and potential manufacturing firms are from the relative employment growth needed for reduction in provincial instability. Briefly, the statistical requirements here should include analysis of (1) manufacturing industry location coefficients,[34] (2) origin and destination of provincial manufacturing shipments (including provincial balance of trade estimates in manufactured commodities),[35] and (3) comparative costs and productivity levels on at least an inter-provincial basis.[36] These data can be utilized to measure the expected social (opportunity) costs of subsidization and deployed together with estimates of provincial benefits from reduced employment instability. The case for possible subsidization should be subject to renewal every 2 or 3 years.

Finally we return to a key point already discussed at some length in Chapter 5. Differential employment growth of provincial industries, whether through market forces or subsidization, can ultimately alter the provincial economic structures that underly our calculations of optimal portfolio composition. This is particularly true where changes in employment distribution become more than just "marginal" and where the time horizon is very long term (as in the dynamic multi-iteration scenarios). In these cases, then, the structural matrices of correlation coefficients (relating cross-industry employment fluctuations around long-term trend), must be monitored for significant change. The coefficients themselves are meant to embody both short-term and medium-term relations and so cannot be expected to reflect frequent changes. We would recommend an updating of these basic matrices once every 2 or 3 years. But the matrices should continue to be calculated on the basis of moving long-term employment patterns of at least 10 to 12 years' duration. All this would provide the essential experience needed for efficient application of optimal industrial diversification at the provincial or sub-provincial level.

Notes

1 The complete discussion of these issues can be found in Chapters 2 and 3. See also Tables 3-2 and 3-4.

2 The next section on further research suggests steps that might be taken towards a more definitive answer to the original question. See also Economic Council of Canada (1984) on this subject.

3 A good critical account of the traditional view can be found in Conroy (1975).

4 The analysis of diversification also depends on the level of industrial disaggregation; see next section.

5 That is, "significant" in terms of reaching the relatively low levels of employment instability currently experienced by Ontario and Québec (according to our measures).

6 A key technical point is that sectors with relatively large initial employment weights receive correspondingly large "weights" in the quadratic programming procedure. There is a large "payoff" from a low correlation coefficient with such a sector.

7 See again Tables 5-37 to 5-40 in the previous chapter.

8 Strictly speaking, printing & publishing should be considered a local manufacturing industry rather than a secondary manufacturing industry.

9 Suggestions are made in the next section.

10 Mining employment also includes "services incidental to mining" such as exploration and development.

11 It is not possible to test the forestry sectors of the Prairie provinces in this context since the available data is not sufficiently accurate; see again Chapter 2.

12 See the first few paragraphs of the Introduction Chapter 1.

13 This works best when all observed employment growth rates are positive, a condition virtually satisfied by the province of Alberta.

14 This idea is particularly relevant for the multi-iteration scenarios.

15 Simulations along these lines are available from the authors on request.

16 This was seen in Tables 5-1 to 5-8 of the previous chapter; see also Table 4-10 of Chapter 4 and corresponding discussion.

17 It is easy to choose examples from previous results showing that the "guarantee" is not usually present. The possibility of a "guarantee" is more likely when the rules of the game are "neutral" -- as in scenario one of the previous chapter.

18 In most cases the coincidence would be relatively minor.

19 This is argued at length in Economic Council of Canada (1977).

20 There is considerable evidence that this is the situation in Alberta.

21 They also reflect the "common" provincial-wide cyclical impacts on industrial employment behaviour, mentioned earlier in this paragraph.

22 If there is more than one new industry, the situation becomes more complicated but still subject to analysis.

23 See Sharpe (1963) and also Appendix A.

24 The initial employment weight of the new industry equals zero per cent, so the new industry cannot be handled by the rules of the game analogous to existing industries in scenario two.

25 Instability-promoting "losers" become even greater "losers" in most instances.

26 Aggregation also affects the boundary limitations and the provincial economic goal constraints.

27 See, again, Chapter 2 for the rationale of our particular study.

28 The larger-firm survey of our analysis does not yield value-added data (see Chapter 2).

29 There are, though, some important cases where coincidence does exist (e.g., FIRE in all provinces, electrical products in Saskatchewan, chemical products in Alberta, printing & publishing in British Columbia). See also discussion of Table 4-10 in Chapter 4.

30 Employment growth may still be above average.

31 A good introduction to the subject is Pearce (1971).

32 At least compared to the problems faced by an intuitive analysis; see George (1984).

33 The provinces of Western Canada appear to meet this condition, as seen in Jenkin (1983).

34 See Statistics Canada (1979).

35 See Statistics Canada (1983); these data indicate the potential for manufacturing import substitution on an inter-provincial basis.

36 A good exercise along these lines is Auer (1979).

Table 6-1

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Modified Scenario Two, Manitoba and Saskatchewan

Sector	Manitoba	Saskatchewan
	(Per cent)	
1. Forestry	0.5	0.7
2. Mining	2.5	4.8
3. Manufacturing	29.0	17.8
4. Construction	3.2	4.2
5. Transp'n, Comm'n, Utilities	22.4	24.7
6. Trade	22.9	26.4
7. Finance, Insurance, Real Estate	7.3	8.8
8. Commercial Services	9.6	10.2

Table 6-2

Manufacturing Industry and Fictitious Industry Employment Weights After Partially Constrained Optimization to Minimize Employment Instability, Modified Scenario Two, Manitoba and Saskatchewan

Industry	Manitoba	Saskatchewan
	(Per cent)	
1. Food & Beverages	6.4	6.2
2. Printing & Publishing	2.4	1.6
3. Wood Products	0.8	1.6
4. Paper & Allied Industries	1.5	0.7
5. Primary Metals	1.4	1.8
6. Non-Metallic Mineral Products	0.6	-
7. Petroleum & Coal Products	-	0.5
8. Clothing	4.2	0.7
9. Furniture & Fixtures	0.8	-
10. Metal Fabricating	2.2	1.1
11. Machinery	2.1	1.2
12. Transportation Equipment	2.8	0.4
13. Electrical Products	1.2	0.4
14. Chemical Products	0.6	0.6
15. Residual Manufacturing	2.0	1.1
Total Manufacturing	29.0	17.8
Fictitious Industry	2.5	2.5

Table 6-3

Sectoral Employment Weights after Partially Constrained Optimization to Minimize Provincial Employment Instability, Modified Scenario Two, Alberta and British Columbia

Sector	Alberta	British Columbia
	(Per cent)	
1. Forestry	0.5	2.6
2. Mining	7.5	2.3
3. Manufacturing	19.3	29.7
4. Construction	6.7	3.5
5. Transp'n, Comm'n, Utilities	18.1	19.9
6. Trade	22.4	19.2
7. Finance, Insurance, Real Estate	7.6	7.6
8. Commercial Services	15.4	12.6

Table 6-4

Manufacturing Industry and Fictitious Industry Employment Weights After Partially Constrained Optimization to Minimize Employment Instability, Modified Scenario Two, Alberta and British Columbia

Industry	Alberta	British Columbia
	(Per cent)	
1. Food & Beverages	5.2	3.9
2. Printing & Publishing	1.3	1.5
3. Wood Products	1.7	9.4
4. Paper & Allied Industries	0.8	4.4
5. Primary Metals	1.0	2.3
6. Non-Metallic Mineral Products	1.3	0.7
7. Petroleum & Coal Products	0.7	0.2
8. Clothing	0.7	0.5
9. Furniture & Fixtures	0.3	0.3
10. Metal Fabricating	1.6	1.7
11. Machinery	0.8	0.8
12. Transportation Equipment	1.2	1.5
13. Electrical Products	0.5	0.8
14. Chemical Products	1.3	0.7
15. Residual Manufacturing	0.9	1.0
Total Manufacturing	19.3	29.7
Fictitious Industry	2.5	2.5

Table 6-5

Measures of Provincial Employment Instability Before and After Partially Constrained Optimization to Minimize Provincial Employment Instability, Modified Scenario Two, Four Western Provinces

Province	Status Quo	Modified Scenario Two
Manitoba	.0337	.0313
Saskatchewan	.0409	.0374
Alberta	.0541	.0501
British Columbia	.0416	.0393

Table 6-6

Measures of Provincial Employment Instability After Employment Growth Constrained Optimization to Minimize Provincial Employment Instability, Two Levels of Disaggregation, Scenario One, Four Western Provinces

Province	Manufacturing Aggregated	Manufacturing Disaggregated
Manitoba	.0322	.0308
Saskatchewan	.0376	.0361
Alberta	.0503	.0502
British Columbia	.0382	.0376

Appendix A: MATHEMATICAL MODELS OF DIVERSIFICATION ANALYSIS

The major purpose of this appendix is to provide mathematical proofs of assertions made throughout the text. The presentation is kept concise and simple; we try to avoid matrix notation and manipulations. In most cases the essence of the proofs can be given as if there were only two industries (or sectors) in each province -- the generalization to any number of industries is straightforward. It should be noted that the main contribution of the study lies in the text, not in the appendices. This appendix is not meant to be self-contained, but is best read in conjunction with the text particularly for readers who desire more formal statements than appear in the text. We also provide recent references to the diversification literature and show the relation of our portfolio analysis to other studies. The most important aspect of this appendix is the basic decomposition identity, featuring an original (though simple) proof.

Some Basic Calculations

In this section we establish some elementary relationships and formulae. It is assumed that the reader is acquainted with ordinary least-squares (regression) analysis and its properties.

Chapter 3 uses an elementary relationship between the average wage and salary level of an aggregate and its corresponding disaggregates. To show this let:

B_t represent the aggregate wage and salary bill at time t

B_{1t} represent the wage and salary bill of industry no. one at time t

B_{2t} represent the wage and salary bill of industry no. two at time t

Then $B_t = B_{1t} + B_{2t}$ when the aggregate is composed of two industries. The average aggregate wage and salary bill over period t=1 to t=N is then:

$$\overline{B} = (1/N)\sum_t B_t$$

The analogous expressions for industries one and two are then:

$$\overline{B}_1 = (1/N)\sum_t B_{1t} \quad \text{and} \quad \overline{B}_2 = (1/N)\sum_t B_{2t}.$$

So it is easy to see that:

$$\overline{B} = \overline{B}_1 + \overline{B}_2.$$

Similarly we may let:

L_t represent the aggregate total number employed at time t

L_{1t} represent the total number employed in industry one at time t

L_{2t} represent the total number employed in industry two at time t

Then again:

$$\bar{L} = (1/N)\sum_t L_t,\ \bar{L}_1 = (1/N)\sum_t L_{1t} \text{ and } \bar{L}_2 = (1/N)\sum_t L_{2t}$$

so that:

$$\bar{L} = \bar{L}_1 + \bar{L}_2$$

Now let us define the average wage and salary level of an aggregate over period t=1 to t=N as:

$$\bar{w} = \bar{B}/\bar{L}$$

Similarly the average wage and salary level of industries one and two over the period are:

$$\bar{w}_1 = \bar{B}_1/\bar{L}_1 \quad \text{and} \quad \bar{w}_2 = \bar{B}_2/\bar{L}_2$$

Then by using the definitions given above we could establish that:

$$\begin{aligned}\bar{w} &= (\bar{B}_1+\bar{B}_2)/(\bar{L}_1+\bar{L}_2)\\ &= \bar{w}_1(\bar{L}_1/\bar{L}) + \bar{w}_2(\bar{L}_2/\bar{L})\end{aligned}$$

which means that $\bar{w}$ is a weighted average of $\bar{w}_1$ and $\bar{w}_2$; each industry is weighted by its respective average employment weight $(\bar{L}_i/\bar{L})$, i=1,2.

Chapter 3 also uses an elementary relationship between the average annual (compound) growth rate of total number employed in the aggregate and its corresponding industry disaggregates. We again assume that the aggregate is composed of two industries (the generalization to any number of industries is trivial). In this case let:

g represent the average annual growth rate of aggregate total number employed over the time period $t=1$ to $t=N$.

g_1 and g_2 represent the average annual growth rate of total number employed in industries one and two respectively over the same time period.

Then it is possible to show that (See Postner (1971)):

$$g \simeq g_1(\bar{L}_1/\bar{L}) + g_2(\bar{L}_2/\bar{L})$$

noting that the relationship is an approximation, though the approximation error is known to be close to zero in almost all examples of our application. In order, however, to avoid any problems of approximation error, we first calculate g_1, g_2 and the respective employment weights $(\bar{L}_i/\bar{L})$ $i=1,2$, and then define $\tilde{g}$ so that:

$$\tilde{g} = g_1(\bar{L}_1/\bar{L}) + g_2(\bar{L}_2/\bar{L})$$

using $\tilde{g}$ as the applied average annual growth rate of aggregate total number employed over the relevant time period. Thus $\tilde{g}$ is a weighted average of g_1 and g_2 with each industry weighted by its average employment weight.

The most important aspect of Chapter 3 is the calculation of aggregate and disaggregated measures of employment instability over a given time period. The derivation of the measures is described in non-mathematical terms in the text. Here we show the basic formula using a general notation which will prove useful in the next section of this appendix. The formula is applicable to any single measure of employment instability, either aggregate or disaggregate. The basic formula is:

$$\left[\frac{\sum_t (x_t - \hat{x}_t)^2}{(N-3)\,\bar{x}^2}\right]^{\frac{1}{2}}$$

where we let:

x_t represent (actual) total number employed at time t

$\bar{x}$ represent the average total number employed over the given time period running from t=1 to t=N

$\hat{x}_t$ represent (estimated) trend total number employed at time t, the estimate coming from a non-linear (quadratic) least-squares regression equation fitted to x_t as the dependent variable and t and t^2 as the independent variables. This means that $\hat{x}_t = \hat{\alpha} + \hat{\beta}t + \hat{\delta}t^2$ using the notation $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\delta}$ to signify the estimated regression coefficients.

3 represents the degrees of freedom lost in the regression process.

It is now easy to see that the basic formula does have the desirable properties described in the text chapter. It might also be noted that the arithmetic sum of actual employment residuals around the estimated moving trend of employment equals zero, that is:

$$\sum_t (x_t - \hat{x}_t) = 0$$

which follows from a well-known property of least-squares regression.

Proof of Decomposition Identity

We will now prove the decomposition identity with respect to the measure of employment instability. The identity exposes the disaggregation property of the basic formula (given above) and is also essential for understanding our model of optimal portfolio analysis and diversification explained in the next section. Again, for simplicity, we assume that aggregate employment consists of employment in two industries. Let:

y_t represent (actual) total employment in industry one at time t

z_t represent (actual) total employment in industry two at time t

and so: $x_t = y_t + z_t$.

Then by introducing completely analogous notation for the two industries, as developed for the basic (employment instability) formula, we find that the measures of employment instability in the two industries are:

$$\left[\frac{\sum_t (y_t - \hat{y}_t)^2}{(N-3)\,\overline{y}^2}\right]^{\frac{1}{2}} \quad \text{and} \quad \left[\frac{\sum_t (z_t - \hat{z}_t)^2}{(N-3)\,\overline{z}^2}\right]^{\frac{1}{2}}$$

The problem now is to relate the basic formula measure for the aggregate x, to the corresponding formulae for the disaggregates y and z. In the proof to follow we use the facts that:

$\overline{x} = \overline{y} + \overline{z}$ (trivial to show)

$\hat{x}_t = \hat{y}_t + \hat{z}_t$ (a property of least-squares regression estimates)

and let:

a represent $(\overline{y}/\overline{x})$

b represent $(\overline{z}/\overline{x})$

so that a + b = 1. Then:

$$\frac{\sum_t (x_t - \hat{x}_t)^2}{(N-3)\,\bar{x}^2} = \frac{\sum_t [(y_t - \hat{y}_t) + (z_t - \hat{z}_t)]^2}{(N-3)\,\bar{x}^2}$$

$$= a^2 \frac{\sum_t (y_t - \hat{y}_t)^2}{(N-3)\,\bar{y}^2} + b^2 \frac{\sum_t (z_t - \hat{z}_t)^2}{(N-3)\,\bar{z}^2}$$

$$+ 2ab \frac{\sum_t (y_t - \hat{y}_t)(z_t - \hat{z}_t)}{(N-3)\,\bar{y}\,\bar{z}}$$

This means that the square of aggregate employment instability is identically equal to a quadratic weighted summation of the squares of disaggregated employment instabilities and the analogous cross-products of the employment residuals of the two industries. The weights of the quadratic form, namely a and b, are the simple average employment weights of the same two industries. This coincides with the text description of Chapter 4.

To further clarify the above decomposition identity, consider the special case where the employment residuals around trend of the two industries are perfectly and positively correlated. This would mean that:

$$\sum_t (y_t-\hat{y}_t)(z_t-\hat{z}_t) = [\sum_t (y_t-\hat{y}_t)^2]^{\frac{1}{2}}[\sum_t (z_t-\hat{z}_t)^2]^{\frac{1}{2}}$$

It is convenient now to introduce some additional notation. Let:

x* represent the measure of aggregate employment instability

y^* represent the measure of employment instability for industry one

z^* represent the measure of employment instability for industry two.

Then applying this notation to the special case we find that:

$$(x^*)^2 = a^2(y^*)^2 + b^2(z)^2 + 2ab[(y^*)^2(z^*)^2]^{\frac{1}{2}}$$

$$= a^2(y^*)^2 + b^2(z^*)^2 + 2ab(y^*)(z^*)$$

$$= (ay^* + bz^*)^2$$

which of course means that:

$$x^* = ay^* + by^*.$$

In this special case we indeed find that aggregate employment instability is equal to an arithmetic weighted average of the two disaggregated employment instabilities. The weights are the familiar respective average employment weights of the two industries.

It is now easy to consider other special cases already described in Chapter 4. If the employment residuals around trend of the two industries are perfectly and negatively correlated then:

$$x^* = [(ay^* - bz^*)^2]^{\frac{1}{2}}$$

If the employment residuals around trend of the two industries are *zero* correlated then:

$$x^* = [a^2(y^*)^2 + b^2(z^*)^2]^{\frac{1}{2}}$$

Moreover aggregate employment instability is at a maximum, *ceteris paribus*, when the industries' respective employment residuals around trend are perfectly and positively correlated. This final characteristic follows from the definition of a correlation coefficient. All these propositions can be generalized when there are any number of industries in the aggregate.

It is useful for later reference to write the decomposition identity (with two industries) in simple matrix notation. Before doing this we let:

$(y_* z)$ represent the cross-product term $\dfrac{\sum_t (y_t - \hat{y}_t)(z_t - \hat{z}_t)}{(N-3)\,\bar{y}\,\bar{z}}$

Then the decomposition identity (general case) becomes:

$$(x^*)^2 = a^2(y^*)^2 + b^2(z^*)^2 + 2ab(y_* z)$$

which in matrix notation is simply:

$$(x^*)^2 = (a \quad b) \begin{bmatrix} (y^*)^2 & (y_* z) \\ (y_* z) & (z^*)^2 \end{bmatrix} \begin{pmatrix} a \\ b \end{pmatrix}$$

Note that the matrix of squared disaggregated own-employment instabilities and cross-employment instabilities (using the language of Chapter 4) can be transformed into a matrix of correlation coefficients by:

$$\begin{bmatrix} y^* & 0 \\ 0 & z^* \end{bmatrix}^{-1} \begin{bmatrix} (y^*)^2 & (y_* z) \\ (y_* z) & (z^*)^2 \end{bmatrix} \begin{bmatrix} y^* & 0 \\ 0 & z^* \end{bmatrix}^{-1} = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

where

$$\rho = \frac{(y_* z)}{(y^*)(z^*)} = \frac{\sum_t (y_t - \hat{y}_t)(z_t - \hat{z}_t)}{\left[\sum_t (y_t - \hat{y}_t)^2\right]^{\frac{1}{2}} \left[\sum_t (z_t - \hat{z}_t)^2\right]^{\frac{1}{2}}}$$

which is indeed the correlation coefficient between the employment residuals around the respective long-term moving trends of the two industries in the aggregate. The complete generalization to any number of industries is straightforward. The matrix transformation to correlation coefficient form is useful since the coefficient ρ is much easier to interpret than the cross-product term $(y_* z)$. Nevertheless it is the cross-product term inter alia that ultimately determines the measure of employment instability in the aggregate, namely x^*. So both the matrix of squared disaggregated own- and cross-employment instabilities and its corresponding (symmetric) matrix of correlation coefficients (at least the non-diagonal elements) are necessary for a complete analysis.

Models of Optimal Portfolio Analysis

We now show the programming model of optimal portfolio analysis used in Chapter 5. The model is illustrated for the simple case of two industries in the aggregate and is built upon previous notation. A general reference is the Stanford University (1983) package for quadratic programming which supplies the algorithmic routine used in our applications. It is convenient to first rewrite the two basic calculations introduced in the beginning of this appendix as:

$$\bar{w} = a\bar{w}_1 + b\bar{w}_2$$

$$\tilde{g} = ag_1 + bg_2$$

where a represents both $(\bar{L}_1/\bar{L})$ and $(\bar{y}/\bar{x})$
b represents both $(\bar{L}_2/\bar{L})$ and $(\bar{z}/\bar{x})$

and then $a + b = 1$.

Optimal portfolio (or diversification) analysis is based on the following quadratic programming problem. We are required to solve for two numbers, represented by c and d, so that:

$$\underset{(c,d)}{\text{minimize}} \quad c^2(y^*)^2 + d^2(z^*)^2 + 2cd(y_*z)$$

$$\text{subject to:} \quad \begin{aligned} &c\bar{w}_1 + d\bar{w}_2 > \bar{w} \\ &cg_1 + dg_2 > \tilde{g} \\ &h_1(a) > c > f_1(a) \\ &h_2(b) > d > f_2(b) \\ &c + d = 1. \end{aligned}$$

All notation has the same meaning previously explained. Thus the variables c and d must be chosen so as to minimize a quadratic function in c and d where $(y^*)^2$, $(z^*)^2$ and (y_*z) are regarded as known constants. The minimization operation is subject to a number of linear constraints on the variables c and d. The first two constraints are economic goal constraints described in Chapter 5. Again the symbols $\bar{w}_1$, $\bar{w}_2$, $\bar{w}$, g_1, g_2, and $\tilde{g}$ represent known constants. The next two sets of constraints involve the employment redistribution boundary limitations described at length in Chapter 5. The symbols h_i and f_i $(i=1,2)$ merely represent functions of the initial known employment distribution a and b such that: $h_1(a) > a > f_1(a)$ and $h_2(b) > b > f_2(b)$. These functions are fixed in any single application, but do vary depending on the scenario or "rules of the game" of the portfolio analysis. For example, in scenario number one (of Chapter 5) we have:

$$h_1(a) = 1.25a \quad , \quad f_1(a) = 0.75a$$
$$h_2(b) = 1.25b \quad , \quad f_2(b) = 0.75b$$

but in scenario two we might have:

$$h_1(a) = a \quad , \quad f_1(a) = 0.75a$$
$$h_2(b) = 1.25b \quad , \quad f_2(b) = b.$$

The final constraint is merely definitional; the numbers c and d represent a new (optimal) employment distribution and so must sum to unity. The definitional constraint together with the sets of boundary limitations guarantee that both c and d would be positive.

The above quadratic programming problem has the following characteristics. First a "solution" to the problem always exists, namely the original (initial) employment distribution represented by a and b (noting that a+b=1). Indeed it is trivial to see that (a,b) satisfies all the constraints. In this case the "solution" yields:

$$a^2(y^*)^2 + b^2(z^*)^2 + 2ab(y_*z) = (x^*)^2$$

namely the initial measure of employment instability for the aggregate (actually squared). The purpose of the optimal portfolio analysis is to do better than the status quo; in any event it is clear that we can always do no worse (in practical applications we can always do better). Second, the optimal solution to the problem, represented by (c,d), then yields the minimum measure of employment instability for the aggregate, consistent with all the constraints. Third, this minimum measure also happens to be a global minimum and not just a local minimum reflecting the initial employment distribution. This third characteristic follows from the fact that the matrix of constants underlying the quadratic function is a symmetric positive semi-definite matrix. The property is clear from considering the matrix representation of the decomposition identity given in the previous section and the definitional measure of aggregate employment instability given in the first section of this appendix. The fourth characteristic of our quadratic programming problem is the obvious observation that the problem as stated and formulated indeed "puts everything together" in a systematic framework. This property is spelled out at considerable length in the text.

A useful feature of our quadratic program is the identification of constraints that are binding in contrast to those that are non-binding. Consider, for example, the first economic goal constraint. At the optimal employment distribution (c,d) we may have either:

$$c\bar{w}_1 + d\bar{w}_2 = \bar{w}$$

or:

$$c\bar{w}_1 + d\bar{w}_2 > \bar{w}.$$

In the case of equality, the constraint is binding and the associated Lagrange multiplier is positive (aside from exceptional circumstances). The multiplier then yields an estimate of the marginal cost of the constraint (or "shadow price"). If the constraint is not imposed, the minimum aggregate employment instability would be lower, depending inter alia on the shadow price of the constraint. On the other hand, in the case of inequality, the constraint is non-binding. The associated Lagrange multiplier is zero and the optimal solution for employment distribution yields, as a by-product, an economic goal level higher than required. One might say that the economic goal requirement is surpassed "free-of-charge" since the optimal (minimum) measure of aggregate employment instability is not "penalized". Indeed, in this case the constraint can be omitted from the program. There is, however, no way of telling in advance which case (equality or inequality) is present until the program and associated algorithmic analysis is performed. Similarly the marginal cost of an effective constraint is not known until the calculations are complete. Analogous remarks apply to the other economic goal constraint in the quadratic programming problem. The complete results in our particular applications are summarized in Tables 5-33 to 5-37. It might also be noted that another implicit constraint associated with the two economic goal requirements is always non-binding and, therefore, omitted, namely:

$$\infty > c\bar{w}_1 + d\bar{w}_2$$

$$\infty > cg_1 + dg_2.$$

The situation with respect to the two sets of boundary limitation constraints is essentially similar. For example we might have:

$$h_1(a) = c \quad \text{or} \quad c = f_1(a) \quad \text{or} \quad h_1(a) > c > f_1(a).$$

In the first case, employment redistribution is such that industry number one attains its maximum permissible level in terms of employment weight. Again there is a Lagrange multiplier associated with this case; the "shadow price" of the constraint is actually negative since the employment weight is prohibited from becoming even larger. This case characterizes industries which are clearly stability-promoting "winners" (as discussed in Chapter 5). In the second case, employment redistribution is such that the relevant industry is pushed down to its minimum permissible level in terms of employment weight. The associated Lagrange multiplier is (normally) positive -- the marginal cost of prohibiting an even greater decrease in initial employment weight. This case, then, characterizes industries which are clearly instability-promoting "losers" (as discussed in Chapter 5). The third case is more complicated. There are two relevant subcases:

$$h_1(a) > c > a > f_1(a)$$

and:

$$h_1(a) > a > c > f_1(a).$$

In the first subcase, the industry is a stability-promoting "winner"; in the second subcase, the industry is an instability-promoting "loser". In both subcases, the associated Lagrange multipliers equal zero and so the constraints represented by the boundary limitations are redundant. Again there is no way of telling in advance which case (or subcase) is present unless the quadratic programming calculations are actually performed. In our particular applications, either the upper bound or the lower bound of the relevant industry boundary limitations prove to be effective; the third case (with the two subcases) is rarely shown. This is precisely the reason why the dynamic (multi-iteration) scenarios succeed in yielding lower levels of aggregate employment instability (after appropriate constrained minimization) than the corresponding static (single-iteration) scenarios. This point is illustrated at length in the third section of Chapter 5.

Finally we can briefly formulate a point discussed in the first section of Chapter 6. The average annual growth rates of employment for the two industries, represented by g_1 and g_2, have a feedback impact on the two (optimal) employment distribution weights, namely c and d (with $c+d=1$). Certain assumptions can be made to abstract from this impact, as mentioned in the discussion of Chapter 6. It is possible, however, to formulate a treatment of the problem which retains simultaneity. In this treatment, the second economic goal constraint is rewritten as:

$$cg_1(c,d) + dg_2(c,d) > \tilde{g}$$

where g_1 and g_2 are still the known employment growth rates of the two industries, but shown as functionally dependent on both c and d. Then the quadratic programming problem is no longer subject to only linear constraints. The modified economic goal constraint is now non-linear (indeed functionally dependent) in c and d and available programming algorithms are inapplicable. In the special case where the (non-linear) economic goal constraint is non-binding, then we may simply omit the constraint and proceed with the available algorithm. But this special case is usually not apparent in advance.

Brief Notes on Portfolio (and Related) Literature

This brief section provides an annotated list of the economic literature most relevant to the concerns of the appendix. The list is somewhat personal; these are the readings we found to be most useful, either directly or indirectly, as technical background for an analysis of (provincial) industrial diversification based on a portfolio analogue. Most of the readings have not yet been explicitly mentioned in the study, but all the readings were essential for our professional development.

The best single reference is Tobin (1965), and provides a general economic introduction to the subjects of diversification and portfolio selection. Tobin, however, is not concerned with empirical calculations or programming; for this we must turn initially to Markowitz (1959). Both Tobin and Markowitz are implicitly concerned with financial investment theory and related portfolio analysis. An excellent application outside of the latter area is Brainard and Cooper (1968); they apply optimal portfolio theory to international trade under uncertainty. Further background relevant to technical problems of stating an objective function can be found in Levy and Markowitz (1979). The most recent exposition of general theorems that can be proved with respect to diversification is now available in MacMinn (1984).

An important application of diversification theory to regional industrial employment is Conroy (1974). His analysis differs from ours in several respects: (1) Conroy is restricted to manufacturing and takes no account of the regional-wide context, (2) a quadratic function similar to ours is minimized with respect to employment distribution, but the operation is not subject to economic goal and boundary limitation constraints, (3) Conroy does not prove the basic decomposition identity, (4) there are no dynamic scenarios, and (5) Conroy assumes that the matrix of own- and cross-employment instabilities is the same for all "regions". On the other hand, Conroy succeeds in analyzing manufacturing in much greater detail than our study. Another, more recent application of portfolio theory to industrial employment diversification is Brown and Brown (1983). The analysis is quite primitive, but is based on an approximation to Tobin-Markowitz procedures originally introduced by Sharpe (1963). This approximation, called the diagonal method, is worthwhile following up when complete data are not available. The reader, though, should also be aware of Markowitz (1983) and related criticisms of the method.

The best available computer package for quadratic programming is the Stanford University (1983) algorithm. Some features of this package have already been described in the preceding section. It should be noted that the package *per se* does not permit multi-iteration scenarios. The package, however, can be easily modified to run dynamic scenarios as was done for this study. Readers are encouraged to contact the authors for further detail. It is even possible to run more general types of dynamic scenarios than we have so far accomplished. A good background to quadratic programming technique can be found in Gill *et al* (1981).

There are many aspects of regional economic theory relevant to the concerns of this study. A particular, and not well-known, paper by Johansen (1967) was basic to our thinking about the effectiveness of regional economic goal constraints. The paper contains a remarkably clear introduction to the economic interpretation of Lagrange multipliers in a regional context. A province, or sub-provincial area, wishing to apply the portfolio techniques of this study within a complete decision-making apparatus, would be well-advised to review the literature on regional location coefficients, as in Schwartz (1982), and cost-benefit analysis, as in Treasury Board (1982). Our intensive development of industrial employment diversification, based on a portfolio analogue, has precluded an investigation of all related matters.

Appendix B

STATISTICAL DATA TRANSFORMATIONS

This appendix elaborates on the description of data sources in Chapter 2 and gives technical details to clarify certain of the calculations in other chapters. More particularly, the coverage of the Employment, Payrolls and Manhours survey is examined from another point of view; the use of wage and salary levels averaged over the full period 1970-83 is justified; and selected findings flowing from experiments with the Labour Force Survey data are reproduced. The computer package is described and the methodologies for computation of average annual growth rates and for scaling in the charts are outlined.

Further Background to the Data

We have seen that coverage of employment in commercial industries by the Employment, Payrolls and Manhours survey was generally very good and for particular sectors, especially manufacturing, was excellent. Unfortunately we were able to make these observations only at the sectoral level. Data limitations prevented us from drawing any conclusions regarding coverage at the level of the individual manufacturing industries for the historical period. Early in 1983, however, Statistics Canada began publication of employment data based on a considerably revised survey. Major amendments were made to the survey including extension of coverage to include firms of all sizes rather than only those with 20 or more employees, the addition of several industries (education, health and welfare services and public administration for example), the adoption of a mixture of census and sampling methodologies with a part of the sample rotating each month, and a switch to the 1970 version of the Standard Industrial Classification. To assist users in making the transition from the old to the new survey, estimates produced by each survey were published for March 1983. We thus had our traditional employment estimates for individual manufacturing industries as well as total employment estimates for those same industries for the final month in our sample. With these data in hand we could make calculations comparable to those in Table 2-1 at a finer level of industrial disaggregation.

As would be expected, larger-firm survey employment relative to total estimated employment in individual manufacturing industries varied from the average for total manufacturing in each province -- sometimes exceeding and sometimes falling short. There were the occasional cases where coverage fell to a percentage in the mid-fifties but in most cases, coverage was close to the average for total manufacturing and at times even in excess of it. We concluded that in many manufacturing industries, the coverage continued to be excellent and in no case was it alarmingly poor. Appendix Table B-1 indicates our results.

The discussion thus far has focused on the extent to which data from the Employment, Payrolls and Manhours survey has covered total estimated employment. It is also interesting to note the share that this employment data assumes of the total estimated wage bill. The revised survey allows this additional comparison. Employment and average weekly earnings data were each available for March 1983 according to both the larger-firm survey and the revised (all-size firm) survey. The product of employment and average weekly earnings gave the weekly wage bill and the ratio of larger-firm wage bill to all-size firm wage bill gave the required estimate of the share of the total wage bill drawn by the larger-firm survey employment data.

One could anticipate that larger firms would pay higher average weekly wages than smaller firms and could reason that employees in those firms would consequently draw a greater proportion of total wages than their weight in total employment. This in fact proves to be true. Appendix Table B-2 shows that, with only two exceptions, coverage of the total wage bill by the unrevised Employment, Payrolls and Manhours survey employment data is even better than its coverage of total estimated employment.

One of the four statistical measures basic to the study was the average weekly wage and salary level of the total labour employed. The measure was shown for each sector and manufacturing industry in Chapter 3 and was used in the portfolio analysis of Chapter 5. It was calculated as the average of monthly observations over the

1970-83 period. We felt that an average over the whole period gave an adequate representation of provincial wage differentials throughout the thirteen years. This belief followed from the fact that relative wages had remained approximately constant between 1970 and 1983. To confirm this statement, average annual growth rates in average weekly earnings were calculated for each sector and industry. The results appear in Appendix Table B-3. Growth rates for all industries, with the exception of three in Saskatchewan, were all roughly of the same magnitude. Because the growth rates of disaggregated wage rates were virtually the same for all sectors and industries, we could also conclude that the aggregate wage rate growth rate was not sensitive to changes in distribution at the disaggregated level.

The final point to be made in this section relates to the data derived from the Labour Force Survey. Our analysis was applied to employment data compiled from the LFS at the aggregate level (see for example Table 3-3) but for several reasons listed in Chapter 2, it was not worthwhile to proceed to the disaggregated level. A primary reason was the inadequacy of data for individual manufacturing industries. We were able to combine manufacturing industries into three meaningful groups -- local, primary, and secondary manufacturing -- but the diversification analysis did not yield useful results at this level. It is interesting, however, to look at the employment weights corresponding to these manufacturing subsectors for each province. They appear in Appendix Table B-4. It should be remembered that these weights are relative to total provincial employment as defined by the LFS and hence including agriculture, non-commercial services and public administration and defence. Many of the percentages in Table B-4 are predictable to even the casual observer -- the large relative weight of primary manufacturing in British Columbia and the large weight of secondary manufacturing in Quebec and Ontario, for example. More of a surprise to the uninitiated is the large relative share of secondary manufacturing employment in Manitoba.

Technical Notes on the Methodology

The bulk of the analysis was handled by a computer programming package called SAS (Statistical Analysis System). The only major exception was the optimal portfolio analysis of Chapter 5. SAS is an easy-to-use system with facilities for information storage and retrieval, file handling, data modification and programming, and statistical analysis. A particularly useful operation was "Proc Matrix" since it treated several time series as a unit (a matrix) and performed calculations on all simultaneously.

The four statistical measures of Chapter 3 and the cross-sectoral/cross-industry employment instability measures and correlation coefficients of Chapter 4 have all been calculated using SAS. Calculation of the first measure, average total labour employed in each sector or industry, was simply a matter of calculating the mean of the 156 observations from January 1970 to March 1983. The employment weight of each sector relative to the province-wide employment was equal to the sectoral mean divided by the provincial mean. In Chapter 4, two sets of sectoral employment weights were calculated in order to trace the effect of changing weights over time on provincial employment instability. The 1970-72 weight equalled the sectoral mean over the 24 months from April 1970 to March 1972 divided by the provincial mean over the same time period and the 1980-83 weight equalled the sectoral mean over April 1981 to March 1983 divided by the corresponding provincial mean. The third statistical measure of Chapter 3, the average weekly wage and salary level, was again a straightforward computation of the mean of monthly observations over the relevant time period.

The second measure, average annual (compound) growth rates in sectoral/industrial employment, were calculated using the method of log linear least squares applied to monthly observations. There are a variety of methods of computing growth rates, including the method of end points and restricted least squares. The method selected has the advantage of using all information in the sample, unlike the end points method which can be sensitive to initial and final observations, and of being relatively easy to program. Growth rates were derived for individual sectors and manufacturing industries and a weighted average was taken for comparison to the annual average growth rate for the industrial composite. This served as a check on the data.

Programming computation of the instability measures, both own- and cross-sector and -industry was somewhat more involved but certainly not difficult. The procedure will not be repeated here but could be made available to interested readers. Several experiments were performed on the program before final application to the Employoment, Payrolls and Manhours survey data. For example, we initially calculated deviations of employment from a linear trend but decided to shift to a nonlinear trend when we extended the time period. If in fact the trend was linear, it would show up as a special case of the nonlinear trend. We also considered the use of deseasonalized data but since it was not immediately available from Statistics Canada and since our concern was with employment instability, we decided to leave seasonal fluctuations in the data. They were dampened, however, by our shift to two-month average observations.

The provincial correlation coefficients (Tables 4-3 to 4-8 and 4-12 to 4-15) were derived directly from the provincial matrix of squared and cross-product employment deviations (the variance-covariance or VC matrix). The correlation coefficient matrix was simply the product of the inverse of the square root of the diagonal elements of the VC matrix times the VC matrix times the inverse of the square root of the diagonal elements of the VC matrix. The underlying theory is described in Appendix A. Since the VC matrix included a residual sector for Quebec, Ontario and British Columbia, the corresponding correlation coefficient matrix also had a residual sector. Observations in the residual sector were random and consequently they were uncorrelated with observations in any other sector. This meant that values appearing in the row and column of the correlation matrix corresponding to the residual sector were close to zero. They were thus omitted from the tables of Chapter 4.

The format of the charts in Chapter 4 has been summarized in the text. To repeat, the horizontal axis measures time running from the April-May 1970 average observation to the February-March 1983 average observation -- yielding 78 semi-monthly observations. The vertical axis measures a scaled version of employment. Each observation, whether actual or trend, has been multiplied by 100 and divided by the mean of the actual. This implies that whenever the actual or trend value equals the mean, the value on the chart is 100. The purpose of the scaling is twofold. First, it facilitates comparability between sectors and industries since there is so much variability in employment levels and second, it allows visual interpretation of the employment instability measure. That is, crudely speaking, a sector's instability measure is the average of the absolute deviations of an observation from its trend value standardized by the mean of the observations. In the chart, at any point in time, the vertical distance between the scaled observation and the scaled trend represents the "deviation of an observation from its trend value standardized by the mean" and consequently the average of these vertical distances gives an indication of the instability measure for that sector.

Table B-1

Larger-Firm Survey Employment Relative to[1] Total Estimated Employment, Selected Manufacturing Industries, March 1983, Four Western Provinces

Industry	Manitoba	Saskatchewan	Alberta	B.C.
1. Food and Beverages	B	C	B	B
2. Printing and Publishing	C	D	C	E
3. Wood Products	C	A	C	B
4. Paper and Allied Industries	A	A	A	A
5. Primary Metals	A	-	A	A
6. Non-Metallic Mineral Products	A	-	B	C
7. Petroleum and Coal Products	-	A	A	A
8. Clothing	B	-	A	C
9. Furniture and Fixtures	D	-	E	E
10. Metal Fabricating	C	E	E	D
11. Machinery	A	D	D	B
12. Transportation Equipment	A	E	B	D
13. Electrical Products	A	A	C	B
14. Chemical Products	A	-	A	C
Total Manufacturing	B	C	C	B

---

[1] Different concepts in the old and new survey prevented precision in these estimates. Rather than actual percentages, we present here indicators of the coverage of the larger-firm survey. The indicator is "A" whenever the larger-firm survey employment as a percentage of total estimated employment exceeds 90 per cent. The indicator is "B" when the percentage is 80-89 per cent, "C" for 70-79 per cent, "D" for 60-69 per cent and "E" for 50-59 per cent.

Table B-2

Larger-Firm Survey Employment and Wage Bill as a Percentage of Total Estimated Employment and Wage Bill, Sectoral Level, March 1983[1]

Sector	Quebec		Ontario		Manitoba		Saskatchewan		Alberta		B.C.	
	Empl.	Wage	Empl.	Wage	Empl.	Wage	Empl.	Wage	Empl.	Wage	Empl.	Wage
	(Percent)											
1. Forestry	73	78	74	78	-	-	-	-	-	-	62	70
2. Mining	90	90	90	93	98	99	95	99	79	83	94	97
3. Manufacturing	82	87	84	87	85	90	77	85	77	83	81	87
4. Construction	41	48	48	58	41	50	36	46	51	61	42	55
5. Transportation, Communication Utilities	87	93	89	94	94	98	87	92	85	89	86	90
6. Trade	52	56	58	60	64	66	52	53	59	62	53	59
7. Finance, Insurance, Real Estate	71	77	78	83	75	81	68	73	75	79	71	74
8. Commercial Services	49	51	55	60	56	62	47	45	50	49	44	47
Industrial Composite	67	75	71	78	73	81	62	71	65	72	64	73

---

[1] This table should only be used to compare employment coverage relative to wage bill coverage. The figures in the table are not precise and ought not to be taken out of context. They are reported only to show that wage coverage is greater than employment coverage where it is assumed that the imprecision affects both employment and wages and will not seriously affect the observed relationship one to another. Table 2-1 appearing in the text is a more accurate picture of employment coverage since it is data officially released by Statistics Canada. Table B-2 is based on observations for only one month, March 1983, and uses only published numbers, with no adjustments for changes in the survey or allowances for information restricted to Labour Division at Statistics Canada.

Table B-3

Growth Rates in Average Weekly Wage and Salary Levels, 1970-1982, Four Western Provinces

Industry	Manitoba	Saskatchewan	Alberta	B.C.
		(Percent)		
1. Forestry	←----------	11.8	----------→	11.3
2. Mining	9.8	11.5	11.6	10.9
3. Manufacturing	9.9	10.4	11.2	10.9
4. Construction	10.0	11.0	11.3	10.6
5. Trnsp'n, Comm'n, Utilities	10.6	10.2	11.0	10.8
6. Trade	8.9	9.4	9.4	9.7
7. Finance, Insurance, Real Estate	10.1	11.3	10.9	10.7
8. Commercial Services	9.5	9.4	10.2	9.5
1. Food and Beverages	9.9	10.6	10.5	10.7
2. Printing and Publishing	9.5	11.1	10.4	9.2
3. Wood Products	10.8	11.2	11.6	11.6
4. Paper and Allied Industries	11.2	10.6	12.0	10.8
5. Primary Metals	10.1	9.9	10.9	11.4
6. Non-Metallic Mineral Products	10.6	-	11.3	11.1
7. Petroleum and Coal Products	-	10.6	10.5	11.6
8. Clothing	9.7	7.2	11.2	9.5
9. Furniture and Fixtures	9.5	-	10.9	10.4
10. Metal Fabricating	9.3	13.3	11.0	10.7
11. Machinery	9.7	8.5	11.0	9.9
12. Transportation Equipment	9.6	9.1	10.7	10.8
13. Electrical Products	11.4	10.1	11.5	10.2
14. Chemical Products	10.5	10.4	11.1	10.6

Table B-4

Manufacturing Subsector Employment Weights, 1975-1983, Six Provinces

Province	Local	Primary	Secondary
		(Percent)	
Quebec	3.8	5.5	13.2
Ontario	4.0	4.7	15.7
Manitoba	3.9	2.3	7.6
Saskatchewan	2.2	1.3	2.2
Alberta	2.6	2.3	3.8
British Columbia	2.9	7.8	4.3

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